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THE AMERICAN ENCYCLOPEDIA AND DICTIONARY OF OPHTHALMOLOGY

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Volume III—Cataract in Diabetes to Cocaine Carbolate

CHICAGO
CLEVELAND PRESS
1914

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Cataract in diabetes. See **Cataract, Diabetic.**

Cataract, Intracapsular extraction of. Intracapsular cataracts are delivered in four ways: 1st, that by which the cataract is expressed by pressure applied to the outside of the globe; 2d, that by which the cataract is forced out by an instrument passed into the eye behind it to scoop it out; 3d, by breaking up its zonular attachments by an instrument applied to the anterior capsule; 4th, that by which the cataract is delivered by a combination of two or more of the preceding methods.

The first method is that known as the Smith-Indian*, the second method is best exemplified by the original Pagenstecher operation; the third and fourth by the suction method of Vard Hulen and the later method of dislocating the cataract with capsule forceps (without teeth, Kalt) employed by Knapp, of New York, or the forceps by Stancleanu, of Bucharest (Simpson of Memphis has made these slightly longer, and I have further modified them by having the tips made bulbous).

Historical review. There is no unanimity of opinion as to who, with design and purpose, first extracted a cataract in its capsule. While the evidence is not clear, yet there seems good reason to believe that Daviel, among the different methods he tried, did the intracapsular operation. He says:

''The case which had fallen into our hands (referring to the well known case of the Hermit, of Provincia) made me form the resolution not to operate any more except by opening the cornea and thence to reach the lens in its capsule in order to make it pass through the pupil into the anterior chamber and thence to remove it from the eye.'' The context shows that he did not succeed in the case referred to, but it is clear that he had the idea in mind.

Sharp, an English surgeon born in Jamaica, was one of the first to extract the cataract in the capsule, a fact that seems to be well established by his description of the operation he performed: ''Place the patient in the same situation as for couching. Either open the eyelid with your forefinger and thumb or, better, an assistant may raise the upper lid while you yourself keep down the lower lid. Then with a small knife, holding its edge downward, make a puncture through the cornea near its circumference into the anterior chamber of the eye in such a direction as to carry it horizontally and opposite to the transverse diameter of the pupil; after which you are to pass it towards the nose through the cornea within or outward as near to its circumference as in the first puncture. When you have made the second puncture push the extremity of the blade one-seventh of an inch beyond the surface of the cornea, and immediately cut the cornea downward, drawing the knife towards you as you make the incision. After this you press gently with your thumb against the inferior part of the globe of the eye in order to expel the cataract, and the operation is finished according to the different circumstances, as in the manner proposed by Mons. Daviel.''

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*To distinguish the form of cataract extraction first practiced in Jullundur, India, by (Major) Smith from that known in America as the Homer Smith method, the former will be designated in these pages as the Smith-Indian, or Jullundur operation.

According to Hubbell, Sharp operated without fixing the eyelids, and without a speculum. He delivered the lens in its capsule.

Arlt says: (Graefe-Saemisch. *Handbuch der gesamten Augenheilk.,* Vol. II, p. 261) ''The thought came to Sharp first to remove the lens in its capsule,'' and he also said in the same connection: ''If we possessed a method whereby it would become possible to remove the entire lens we would be called upon to report less losses and still less unsatisfactory results.'' He further said, ''I have shown that it is possible to remove the lens in its capsule without loss of vitreous in cases where the capsule is cloudy and thickened.'' Richter, (Abhandlung von dem Ausziehen des grauen Staars. Goettingen, 1773; Von einer neuen Art den Staar Auszuziehen. *Observationes Chirurgicales,* Goettingen, 1776. Fact. II) a little later, proposed extraction in the capsule in the following manner. He passed the point of a rounded needle through the sclerotic into the posterior chamber and impaled the lens on it, then by moving the handle from side to side and from above downward, and lastly by rotating the lens so as to break up any remaining attachments to the zonula or to the hyaloid he pushed the lens in its capsule forward through the pupil into the anterior chamber from which he extracted it by a lower section and without iridectomy.

It would be useless to attempt to name all the other early operators who have contributed to the development of the operation, but there are operators other than Daviel, Sharp and Richter who have been so closely associated with the development of the intracapsular operation that the study will not be complete unless they are mentioned and their respective methods referred to. Morenheim, in 1781, suggested that the attempt be made, after completion of the corneal section, to deliver all cataracts in their capsule by light pressure on the globe. In 1799 G. J. Beer advised impaling the lens in its capsule, from behind, on a needle as Richter had done more than twenty years before. ''Two indications are given by which the tearing of the zonula of Zinn is found easy for intracapsular extraction for cataract. The first is a cataract with a large nucleus and a small quantity of tenacious cortex. The second is an unripe cataract with a large nucleus ripening slowly, which is most frequently found in myopic eyes.''

Arnemann extracted the cataract through an upper section made with a Beer knife and expelled the lens by a double-ended instrument, one end shaped like a Daviel curette, the other having a spiral tip like a corkscrew for impaling the lens through the pupil and drawing it out of the eye. This operation seems not to have met with favor. It was severely criticised by Himly and Schmidt as dangerous to the eye and not based on sound surgical principles.

History of the modern intracapsular extraction. Little progress was made in the development of the operation until 1845, when Christiaen conceived the steps of the modern intracapsular operation as the rational procedure. He described them as follows: ''The patient is placed on a chair near a window and in such a position that the light falls upon the eyes from the side, and is not reflected by the transparent cornea. An assistant fixes the head against the left side of the chair if I operate on the left eye, and against the right side if the right eye is to be operated on. In the first case the assistant places his right hand under the chin and approaches more or less near the surgeon, who is in front of the patient seated or standing. He then puts the palm of the left hand over the left side of the patient's forehead in such a manner that the extremity of the index and middle fingers shall reach a little below the side of the lower eyelid. By means of an elevator he lifts up the eyelid as much as possible and immediately applies the middle finger to fix it more solidly. He must take care that the end of his finger is sufficiently removed from the eyeball so as not to touch it and exert no pressure upon it. The disposition must, nevertheless, be such that if the eye flies upward under the instruments the projecting part should meet and compel the organ to resume its position.

''The operator in order to look from above downward into the interior of the eye and not be obliged to hold his arms raised must place himself before his patient in such a position that his chest is on a level with the patient's head. He lowers the inferior eyelid with the index finger (of the left hand for the left eye, of the right hand for the right eye), taking care that the extremity of this finger, as that of his assistant, is on the palpebral level; he applies the middle finger over the lachrymal caruncle so as to prevent the escape of the globe to the internal angle—a very serious inconvenience. He seizes the keratome, which he holds like a pen between the thumb, index and middle finger, the cutting edge being in the direction of the incision, upward, downward or obliquely, the point three or four millimeters from the cornea. The ring and little finger rest against the cheek. The instrument is now plunged at the point of election and the cornea traversed with one cut. Once the point of the knife has appeared at the nasal angle it is fixed over the nail of the index finger which depresses the eyelid, and which now serves to conduct the gradual completion of the section, and at the same time by a light pressure upon the upper eyelid the exit of the lens in its capsule is determined.

"After allowing the eye to rest a minute one assures himself whether the edges of the wound are in coaptation and if the capsular fragments are not engaged against the lips of the wound, a circumstance the author has observed, though rarely.

"If it happens that the lens remains, as usual, in place at the completion of the corneal section, he raises the upper eyelid and by lowering the lower eyelid, brings to bear the flat of the curette over the upper part of the eyeball and by a few compressive movements brings about the exit of the lens.

"The anterior capsule is not incised and the extraction as thus performed causes neither wound nor hernia of the iris. The vitreous humor has never come out in the author's experience.

"His armamentarium is a Beer or Wenzel knife, a Daviel curette, fine forceps, two pairs of Daviel scissors. Pellier's elevator is used only when the upper eyelid is too big or is raised with difficulty."

C. Sperino describes his usual method of operating as follows: First, a semilunar cut in the cornea, second, incision of the capsule. The author in twenty cases dispensed with the incision of the capsule, removing the cataract by superior keratotomy, and by external manipulation, as Christiaen had done twelve years before.

Lucca describes his operation as follows: Section of the cornea having been made according to the rules governing the inferior semilunar incision, one introduces through the corneal opening a quite small, ordinary probe, curved and flattened at its extremity, or a cataract needle with a blunt point, which is slipped carefully from below upward between the iris and the capsule as far as the furrow between the iris and the lower part of Petit's canal, holding it always close to the capsule so as not to disturb the posterior surface of the eye.

The instrument is then withdrawn about a line, and the end is moved parallel to the circumference of the crystalline lens, exerting light pressure. By this movement one destroys the very delicate mesh of the hyaloid membrane and the crystalline lens may then be removed in its entirety, either by contraction of the extrinsic muscles of the eye or by methodical pressure, or by assisting the extraction, when necessary, by means of Daviel's curette.

Pagenstecher's operation. But the most important contribution to the literature of intracapsular extraction up to this time was a paper by Alexander Pagenstecher (*Klinische Beobachtungen aus der Augenheilanstalt zu Wiesbaden*, Vol. 3 in 1866). In 1871 his brother Hermann added one still more important. In these papers they so fully covered the indications and contraindications for the operation, and the technical details of its execution, as they were understood and accepted at that time by his brother and himself, that they are interesting reading even in our day, when intracapsular extraction is receiving more attention than at any time in the history of cataract operations.

Of A. Pagenstecher's paper J. Soelberg Wells (*A Treatise of Diseases of the Eye.* 2nd Ed., 1870) says:

"This operation was first practised by Richter and Beer, but fell into disuse until it was some years ago reintroduced, amongst others by Sperino, Pagenstecher and Wecker. Dr. Pagenstecher originally removed the lens and its capsule with much success by the lower flap operation. After practising the extraction of the lens in its capsule for a period of five years, Dr. Pagenstecher has arrived at the following conclusions as to the cases in which it is indicated:

"1. He prefers the extraction of the lens in its capsule to that with laceration of the latter, in all those cases in which it may be presumed that the capsule is firmer than its attachment with the zonula of Zinn. This generally occurs in cases of over-ripe cataract, both in those which are hard and somewhat shrunken, and those which are softish or partly fluid (Morgagnian cataract).

"2. It is also suitable in those cases in which the progress of the cataract is extremely slow, and certain portions of the lens always remain transparent, so that the cataract never becomes perfectly mature. Such cataracts are generally small in size, and the capsule is but very slightly attached to the zonula.

"3. It will, as a rule, be found suitable in those cases of cataract which have become developed after irido-choroiditis and iritis with posterior circular syncchiæ. The adhesion between the capsule and the iris must of course be detached prior to the extraction of the cataract, for which purpose a small blunt-pointed silver hook is to be employed.

"4. It may be recommended where, together with the cataract, there is a tremulous iris; for it will often be found that the latter is caused by a shrinking in the size of the lens, or a diminution of the vitreous humor, which should generally lead us to suspect atrophy of the zonula. The last two categories are, moreover, also suitable for this mode of operation because of the tendency to inflammatory complications of the iris which exists in them; in consequence of which it is a matter of much importance to guard the iris against the irrition produced by remnants of cortical substance or portions of capsule.''

The following extracts from Hermann Pagenstecher's papers further show the gradual growth of his technique:

''A late and rare indication may be encountered in cases, where during the operation, whether during incision or iridectomy, in a word, before opening the capsule, there occurs discharge of the vitreous humor. For these reasons, in every operation for cataract, even when we intend to open the capsule, we are always ready to use the curette.

''Like the indications the rules for operation have undergone important modifications in the course of the last few years. We now use the following method:—In place of the flap which we formerly cut we make a superior linear incision and at the same time a large iridectomy.

''In rare cases, when the globe of the eye is well fixed and turned down, it happens immediately after this operation, that a light pressure on the inferior corneal border brings the lens enclosed in its capsule into view and permits its extraction.

''The extraction of the crystalline lens within its capsule removes all predisposition to an inflammatory process on the part of the iris. In the 200 cases on which we have operated, we have not observed a single primary iritis.

''This operation excludes all secondary operations.

''The acuteness of vision is greater after this operation than after any other. Twelve times out of a hundred the acuteness becomes normal. While it presents all these advantages this operation does not entail more total losses of eyesight than ordinary extraction.

''The defects of this operation consist in the difficulty of operative technic and in reaching an exact diagnosis in certain cases.

''If escape of the vitreous humor is observed it may happen that this substance is included between the edges of the wound and retards healing. This prolapse has never been followed by serious consequences.''

In 1877 he wrote (Extraction des grauen Staares in geschlossener Kapsel, Wiesbaden, 1877): ''The Graefe knife being employed the incision is made upward with a right hand for either eye, care being taken to gain a conjunctiva flap. Following this a deep large iridectomy is made to prevent the prolapse of the iris. With a dull hook the operator loosens any posterior adhesions if they should exist. With a spoon, slight pressure is made over the upper scleral wound and counter pressure on the cornea at the same time; with the forceps the eye is rotated downward.

"This latter step is not to be prolonged since rupture of the hyaloid and evacuation of vitreous may follow.

"In case of failure of extraction by these means a flat spoon is used, which is carefully pushed behind the equator of the lens, keeping the same in contact with the posterior capsule until its edge reaches the lower equator of the lens. Then slight pressure is made on the lower equator so that the lower margin of the lens points forward. The spoon is now slightly rotated so the handle of it will make its excursion from the center of the wound toward one of the corners of the wound. The lens is thus pulled upward by throwing the handle of the spoon toward the orbital curve, the result being that the lens makes its excursion toward the cornea.

"Slight pressure is then made on the cornea by an assistant, combined with slight gliding motion upward facilitating the expulsion and diminishing the chances of the rupture of the capsule."

And, still later, in 1888: "To get the real value of the two methods of operating is very difficult. A practical result can only be obtained when the operator has a great number of cases at his disposal.

"Therefore in the past few years I have made it a rule to operate on all favorable binocular cataracts on one eye by one method and on the other eye by the other method. This as a rule harmonizes with the indications which I some time ago have mentioned, as one finds frequently a hypermature cataract next to a recently ripe one in the other eye. With oblique illumination a regular gray or gray-yellow color of the anterior cortical layer, with no sharp border lines, discloses the presence of the older cataract, whereas in a younger cataract the layers of the anterior cortical surface will have sharp outlines. In cases of over-ripe cataracts the zonula has undergone atrophic changes which favor extraction within the capsule, with or without the use of a flat spoon and, since the use of cocaine, in most all cases without the loss of vitreous.

"With the extraction cum capsula the incision must not be too small, although never larger than one-third of corneal circumference. The best cut edges for a flap are obtained with a double edged knife, and an iridectomy is always in place to avoid prolapsus.

"After the iridectomy follows the replacing of the iridic angles at the corners of the wound. A flat spoon is now very carefully introduced behind, but not past, or at least not much past, the posterior pole of the lens. At this time the assistant presses at the lower part of the cornea with a special constructed glass instrument until the lens appears in the wound. The flat spoon here has more the function of an effective slanting surface on which the lens glides, than that of an instrument for traction purpose.

''If the zonula does not give way the spoon may be pushed a little deeper and with the combined pressure by the assistant on the cornea, the extraction is completed.

''The capsule seldom ruptures if proper selections have been made.''*

Gioppi reports 117 cases operated on with a Graefe knife. An incision is made in the superior quadrant of the sclera, then he introduces a spoon over the superior margin of the lens (after getting the unlacerated iris out of his way) behind the posterior capsule and removes the lens with the unlacerated capsule. Seven failures are reported out of 117 cases. Specific details are omitted. In about one-fifth of the cases the capsule during extraction ruptures. Patients are never bandaged after being operated on, healing taking place in an unusually quick manner. Reports of vision were not given as most of the patients could not read.

In 1870 and 1871 Cannstadt (*Klin. Monatsbl. für Augenh.*, 1871, Vol. 4, pp. 131-134) described the following operation: 1. I direct a slightly curved cataract needle with its convex side towards the lens and behind the latter, giving it to the assistant to hold and fix the eye with it. 2. A corneal flap is then made in the usual manner upwards. 3. I then take charge again of the needle and with considerable pressure on the lens behind, the zonula is forcibly ruptured and the lens within the unruptured capsule landed in the anterior chamber. 4. Slight pressure on the bulb expels the lens readily and the entire operation is completed.''

The writer states he has made five of these operations and every one with good results.

Terson (*Révue Med. de Toulouse*, 1871, Vol. 6, p. 76) describes his operation as follows: ''If all parts of the lens are hard the Graefe

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*The following, more recent, papers may also be consulted, as dealing with the modern history of this form of cataract extraction: H. Pagenstecher. Ueber Extraction mit und ohne Entfernung der Kapsel. *Arch. für Ophthal.*, 1888, Vol. XXXIV, pp. 143-166. Ueber die Kataraktextraction in geschlossener Kapsel. Period. Internat. Ophth. Cong., 1888, VII, 506-511; also, Praktische Rathschläge zur Staaroperation für angehende Augenärzte. *Klin. Monatsbl. f. Augenh.*, 1894, XXXII, pp. 339-352. Würdemann. Expression of Cataract in the Capsule with report of 40 cases. *Jour. Am. Med. Assn.*, Vol. LII, pp. 782-787; also, Expression of Cataract in the capsule. *Ophthalmology*, October, 1909, p. 11.

curette is pressed in front of the fixation forceps and, to press the lens into the corneal wound with the other hand, a curved forceps is introduced into the anterior chamber. Should the nucleus be covered with soft cortical masses the forceps is introduced deeper, as far as the lower margin of the pupil, to try and grasp the capsule alone which is as a rule thicker in the center. If perchance we pull out the cataract with the capsule in this manner, without rupturing the latter, so much the better.

"To pass a curette back of the lens is dangerous because it favors prolapse of vitreous. This is not a slight accident, as other complications may result, especially detachment of the retina."

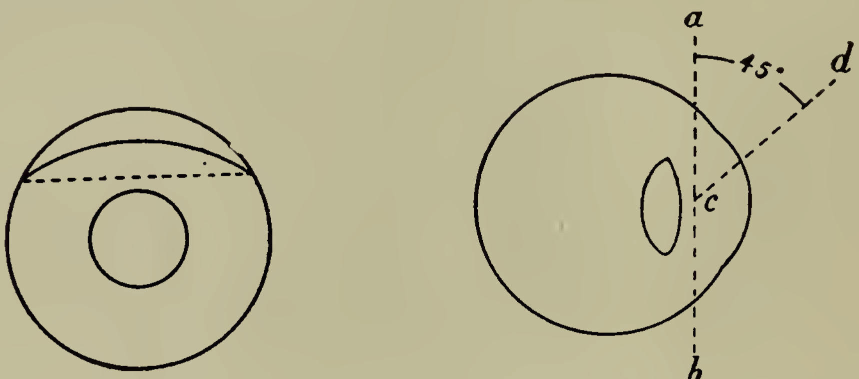
Landesberg's (Berichte über 123 Staar Operationen. *Arch für Ophth.*, Vol. XXIV, 1878, p. 59) extraction within the capsule differed in some respects from the method of Pagenstecher: "His eccentric incision gives easy rise to bleeding so I made Graefe's peripheric linear incision with one sweep of the knife, leaving a conjunctival flap. Pagenstecher leaves a scleral bridge which he later cuts with a pair of scissors. To extract the lens cum capsula I partly employed the spoon of Pagenstecher and partly Daviel's spoon. In two cases I extracted the lens within the capsule with the iris forceps. I grasped the lens with it, and with slow sideward motions dislocated the lens out of the fossa. The lids were held apart with the speculum."

Borysickiewicz (Beiträge zur Extraction des grauen Staares der Erwachsenen. *Klin. Monatsbl für Augenh.*, Vol. 18, pp. 199-230, 1880) found the Pagenstecher method objectionable on account of the danger of prolapse, which he states can hardly be avoided. He describes his method as follows: "The elevator placed, then a sclerocorneal section 3 millimetres wide, made with a Graefe knife, is followed by iridectomy; after this a sharp and flexible iris hook, with a point 1½ mm. in length is pushed flatly between the capsule of the lens and Descemet's membrane downward to the lower pupillary margin where it is turned carefully, to enable a quick and deep insertion into the lens substance. After this had been done, the lens, impaled on the hook, can be extracted direct. A sudden insertion of the hook into the substance of the nucleus causes the entire lens to turn in such a manner that the lower margin is pushed backward, while the upper margin moves forward. By this manipulation in almost every case, a rupture of the zonula at these two spots occurs and makes possible extraction of the cataractous lens in the capsule."

In 1882 MacNamara *(A Manual of Diseases of the Eye,* p. 425) wrote that "having practised this operation constantly since 1864, I am convinced that if it were possible in every case in which we operate to remove the lens in its capsule without damaging the other important structures of the eye we should have reached perfection in the extraction of cataract.''

Wright, (See, also, An Improved Operation for the Extraction of Cataract. *Columbus (Ohio) Medical Journal,* October, 1884) in the 1900 edition of his text book, says:

''For convenience we imagine a transverse horizontal line one-third the way down from the upper edge of the cornea. A medium sized Graefe knife is used in making the incision. The point of entrance must be near the sclero-corneal border but entirely within the cornea on the imaginary line as is shown in the dotted line in the figure.



Wright's Method of Cataract Extraction in the Unruptured Capsule. a, b, c, line of puncture and counter-puncture of the section; d, corneal section.

''The cutting edge of the knife is directed upward and forward, the plane of the knife making an angle of about 45° with the plane of the normal iris, as is shown in the figure.

''The line a-b represents the plane of the normal iris, c-d the plane of the knife.

''The back of the knife must be kept on the imaginary line and the counter-puncture made near the sclero-corneal border. The knife is now steadily and gently pushed forward until the section is completed. The line of the incision will now present the appearance of the curved line in the cut.

''The patient is now allowed to rest a moment when, if the pupil has not dilated well the iridectomy is made. On the other hand—as has been indicated—if the pupil had been fully dilated before the incision was made, the iridectomy is to be omitted.

''The next step in the operation as usually practised, whether an iridectomy has been made or not, is to rupture the capsule of the lens, but I am fully satisfied that as a rule the lens is easily removed within its capsule, especially so in this particular operation.

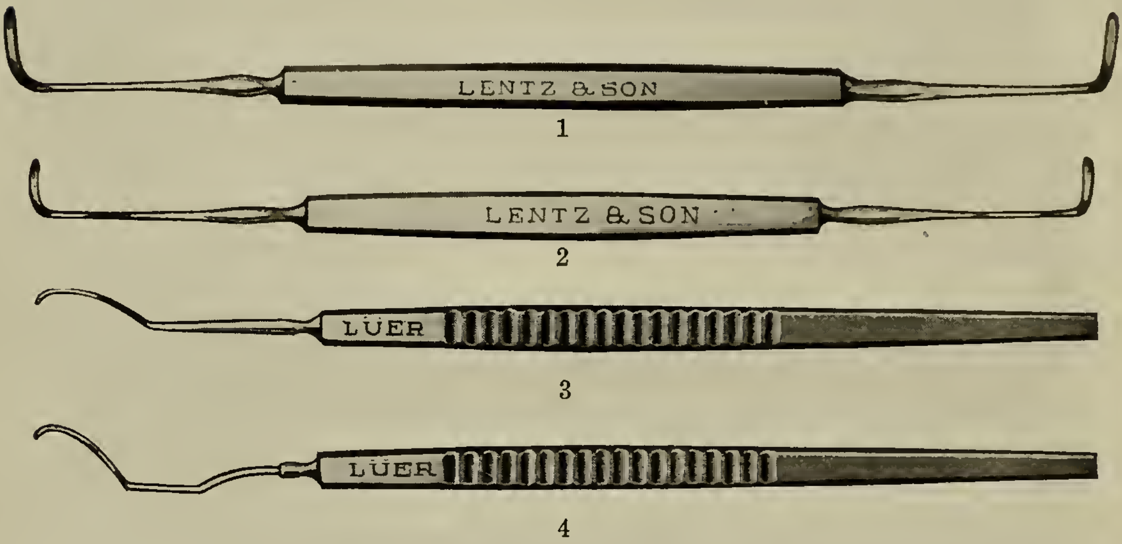
"It is the experience of all who operate for cataract that there would be very few cases of iritis as a result of these operations were it not for the portion of lenticular and capsule which is allowed to remain, and which is frequently impossible to remove, because of the danger of losing vitreous.

"We will then, without rupturing the capsule, take the next step in the operation, which is to press down the upper segment of the cornea with the finger. At the same time, if the lens does not readily present, slight pressure with the finger of the other hand may be made near the sclero-corneal border below. The lens will now present itself and pass through the opening."

Andrew has described the following operation which was performed under an anesthetic: "Through an upper section with iridectomy, no speculum being used, the lens is detached with a piece of stiff wire one inch in length mounted on a handle, having a point smooth and rounded, and a line to a line and a half of its extremity bent at a right angle. An instrument has been formed to be used in the following manner. Either before or after the section a minute opening is made in the cornea close to the margin by a small broad bent needle. The instrument is passed into the anterior chamber sidewise over the lens and under the iris until it reaches its margin. The point is now turned downward and the ligament appears with ease. Following the edge as a guide it may be torn to any extent that the operator may desire. If after the section, the instrument is introduced through any part of the opening found most convenient and whichever course it follows being under the iris, that structure is scarcely touched. The endeavor is to tear the ligament without the slightest injury to the vitreous body, and to accomplish this in the manner above mentioned the bent portion is of different length in order to adapt it to an arched or flat cataract. The lens, on slight pressure by a tortoise-shell curette, may be gently eased through this one opening without the aid of any extraction instrument."

Roosa, of New York, describes an intracapsular operation which he performed with some success, and which had a few imitators, as follows: "The dislocation of the lens is effected by turning the back of the knife two or three times on the surface of the iris and the lens after the corneal incision is made and before the section is finished. The lens is then made to escape by pressure either with the rubber spoon or the fingers and one spoon. Usually it escapes readily. It is important that the corneal section be large. No iridectomy is performed and no instrument enters the eye after the section is made.''

Higgins (On Extraction of Immature Cataract. *The Lancet,* Vol. I, 1888, p. 915) speaking of the treatment of immature nuclear cataract says: ''I remove the lens in its capsule through a small flap section made downwards. The instrument employed for its extraction is the small vectis designed by Bell Taylor. The loss of even a considerable amount of vitreous does not of necessity preclude a fairly successful result. In five out of six cases vitreous was lost. I am of the opinion that loss of vitreous does not materially affect the ultimate result of an extraction, provided the whole cataract is brought away.''



Instruments Used in Intracapsular Extraction. 1, Fox's Detacher; 2, Savage's Detacher; 3, Gradenigo's Zonulatome; 4, Basso's Reclinateur.

D. Basso devised an instrument which he called a reclinateur (see illustration) which fitted over the anterior surface of the lens under the iris. He states that slight pressure with it is usually sufficient to dislocate the cataract, which is then delivered in the usual way.

Gayet (Rapport sur l'opération de la Cataracte. *Bericht d. VII Intern. Ophthal. Congress,* Heidelberg, Aug. 8-11, 1888), in a report on intracapsular extraction, says: ''Extraction should at present be performed without removing the capsule of the lens. Attempts to remove the lens together with the capsule aim at a legitimate, ideal result.''

L. Webster Fox (Delivery of the Lens for Extraction of Cataract. *Jour. Am. Med. Assoc.,* June 4-7, 1907) has devised a corelysis instrument, a modification of Streatfeild's. He has further modified this instrument, which is reversible, one end for the right and the other for the left eye. Later on he left off the sharp tooth and changed the instrument from a zonulatome to a reclinateur which, barring its slightly larger size, is the same as the corelysis instrument. He has also described the following operation in certain cases: ''Passing the Jaeger cystotome into the anterior chamber and hooking the lens at its inferior margin I make a backward pass, at the same time pressing the upper lip of the incision very gently downward and backward. This tilts the upper part of the lens forward. The lens is then brought back into its normal position and this is followed by rotation on its axis, by hooking the cystotome into the capsule. Then removing the cystotome and by counter pressure on the lower third of the cornea with a tortoise shell spatula I express the cataract through the incision without loss of vitreous.''

G. C. Savage has devised a ''cataract-in-the-capsule detacher.'' With the exception of the curve in the shank to fit the anterior face of the lens, and the fact that it is made in three different sizes, a careful examination has failed to show me any special difference between it and Fox's corelysis instrument. In principle it is a reclinateur, the same as Fox's, Gradenigo's or Basso's. I have seen Savage perform the above described operation, and I am sure he is complicating intra-capsular extraction rather than simplifying it by this method. His instrument is not new in principle or method of use.

Pagenstecher quite recently recommended a slight modification in the use of the curette or spoon as follows: ''After an incision of one-third of the corneal circumference and an iridectomy, *the Pagenstecher spoon* [italics mine] is pressed on the scleral lip of the wound and carried over the edge of the lens into the posterior chamber, but never beyond the posterior pole of the lens. Then, by pressure on the lower part of the cornea with a glass rod, the lens is dislocated upward onto the spoon, which acts purely as a gliding surface and never as an instrument of traction.''

traction capsulo-lenticulaire du Prof. Gradenigo. *Ann. d'Oculist,* 1895. Also, Estrazione della cataratta capsulo-lenticolare. *Ann. di Ottalm.,* 1902, Vol. 31, p. 702) has given much attention to this operation and he has had a number of followers. Among the latter are Ovio (Sullo Mechinesimo del'Estrazione capsulo-lenticolare. *Annali di Ottalm.* Vol. XXVIII, p. 86) and Saggini (Nouveau procéde d'extraction capsulo-lenticulaire du Prof. Gradenigo. *Ann. d'Oculist,* CXXII, p. 344, 1899.) Gradenigo believes that the corneal incision must be large, involving a half or even more of the cornea, thus making a very large flap, as in the early days of cataract extraction.

He recommends that the apex of the flap should not coincide with the vertical diameter of the cornea, but should be placed somewhat obliquely between the insertions of the superior and external recti.

The surgeon now introduces a special zonulotome a millimetre beyond the lower visible edge of the iris (the pupil being dilated with atropine), so as to be secure from the risk of wounding the lens, and turns it on to the zonula, holding the instrument very lightly. If there should be any appreciable resistance felt, the surgeon must withdraw the zonulotome, and introduce it afresh. With great care he lacerates the interior part of the zonula, when the lens may be seen to start forwards and upwards. Then he gradually divides the rest of the zonula, as far as possible, after which by gentle pressure of the spoon, taking care not to rupture the hyaloid membrane, the surgeon expresses the lens. To encourage speedy healing, Gradenigo covers the surface of the cornea in the region of the flap by a fold of conjunctiva.

Cassiani (Dell'estrazione capsulo-lenticolare della cataratta. *Annali di Ottalmol.,* Vol. 6, 1897, p. 460) has somewhat modified Gradenigo's operation. This consists in laceration of the lower half of the zonula by means of a kind of cystotome, a small blunt hook which is slipped along the equator of the crystalline lens below.

Of 188 extractions there were only three failures. Ideal results were obtained in 129 cases, good results in 48 cases, fair results in 8 cases.

The Mulroney operation. From the foregoing brief review of the literature of the subject it will be noted that the operations of Pagenstecher and his followers are the only really important ones; and they as a matter of fact continued to be the only methods worthy of serious consideration until certain East Indian surgeons began the practice of removing cataract in its capsule as a routine performance. The enormous material at their command enables them to speak with authority on the subject and it is to them and their pupils that we must chiefly look for additional light on a most important subject.

Lieut. Col. Mulroney, of the Indian Medical Service, then stationed at Amritsar, Punjab, was the first surgeon who began as a routine procedure to extract all kinds of cataracts in the capsule by external manipulation after a method largely his own. So far as I can learn Mulroney has not written a line upon the subject of his operation for publication. Fortunately one of his assistants, the late Meeher Chand Rai Behagur, described the operation fully in a paper which he read at Calcutta. This paper is the most important one written on the subject of intra-capsular extraction since Pagenstecher's contributions in 1866, 1871 and later. He thus describes the principal steps in the operation: "The incision is made by introducing the point of the linear knife into the corneo-scleral junction on the outer side of the globe, on a level with the lower margin of the undilated pupil, the counter-opening being made a little lower on the inner side, and then the incision is completed in the usual way through the cornea. Pressure is now applied with a flat scoop, or a strabismus-hook at the upper border of the cornea, till the edge of the lens presents itself into incision, and then counter-pressure is applied by a curette below the incision; by this process the iris, which is often in the way, recedes, and the lens gradually projects, and when nearly half of it is out of the wound, the pressure is withdrawn and the speculum removed. After this the pressure with the thumb is re-applied to the globe through the upper lid and counter-pressure applied to the ball of the eye below the wound on the sclerotic coat, with a scoop; the pressure is very gently and carefully regulated, till two-thirds of the lens comes out of the wound. Pressure is now again removed, and the patient is directed to close the eye, and look towards his feet, when in most of the cases the lens slips out, and the iris contracts, the edges of the wound become adjusted, and escape of vitreous prevented. In cases where expulsion of the lens is retarded, it is completed by the aid of a scoop or a pair of iris forceps.

"In those cases where the soft cortical substance of the lens comes out, but a hard nucleus remains behind, the capsule is very liable to rupture, unless tact and patience are exercised, till the nucleus also protrudes.

"About 3,400 operations have been performed by this method in the Civil Hospital, Amritsar, of which nearly one-third were performed by myself."

Mecher Chand (A New Operation for Cataract, at the Civil Hospital at Amritsar, India. *Trans. Indian Med. Cong.*, Calcutta, 1894), in describing the operation, incidentally mentions the strabismus hook for delivery of the lens but probably preferred the Daviel spoon, as he mentions it first.

A later description of the steps of the Mulroney operation is by Senior Assistant Surgeon Hari Chand (Mulroney's Operation. *Oph. Record,* July, 1910), who by a peculiar coincidence was Mulroney's last assistant and became Smith's first assistant December 1st, 1909. He thus reviews this operation: "The incision includes just less than half the circumference, the Graefe's knife is entered in the sclero-cornea and the counter-puncture is also in the sclero-cornea. The incision, which is an upper one, is made with a single sweep, finishing in the cornea near its periphery; no iridectomy is done. The patient is now asked *to look toward his feet* [the italics the author's] and pressure is made on the sclerotic above the wound with a curette; the lens is thus dislocated at the wound. As soon as the edge of the lens has made its appearance in the wound through the pupil, the speculum is removed. The assistant then retracts the lower eyelid with his thumb on the face and with the fingers of his other hand draws back the brow and upper eyelid. The operator again asks the patient to look toward his feet and applies pressure on the lower part of the cornea with a curette and with another curette in another hand he makes counter-pressure above the wound till the lens comes out. When the lens is out the assistant releases the eyelids and the operator draws up the upper eyelid by catching the eye lashes with his fingers and adjusts the iris."

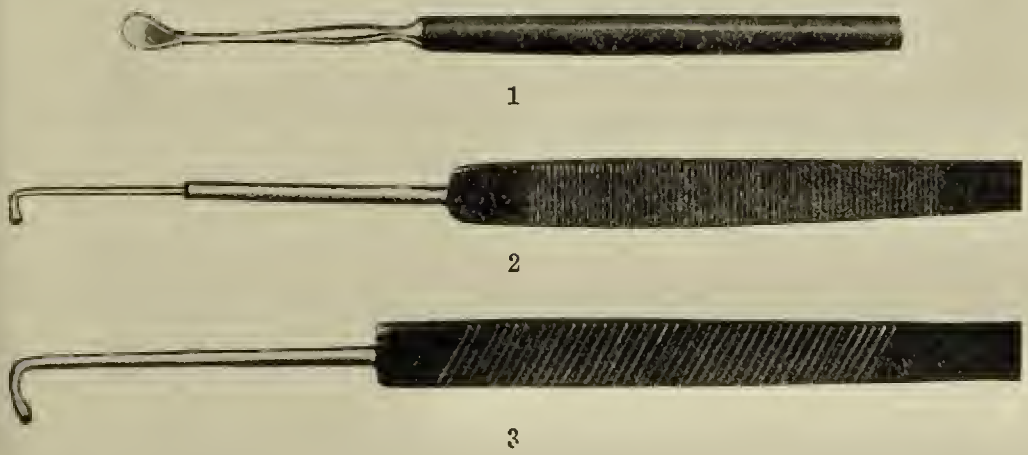
The Smith-Indian operation. From Mulroney's clinic in Amritsar to Jullundur City is only 52 English miles, and Smith, while generally performing the regular operation, saw many cataract cases which had been operated on at Mulroney's clinic. The results were so satisfactory and so much in harmony with his own experience that he determined in 1895 to follow some form of intra-capsular extraction as a routine proceeding. But no method he then knew of was satisfactory because of the position and size of the section, because of the position in which the eye was held and because of the want of control of the upper lid. For these and other reasons the percentage of loss of vitreous was almost prohibitive; and the insufficiency of the instruments employed and the technical details adopted in the delivery of the lens were not satisfactory. Smith accordingly developed his own methods which he has finally brought to such a state of perfection that the Smith-Indian operation may be considered the type of the modern intra-capsular operation, as it is also the latest candidate for favor. If nothing else can be said in its behalf the fact that it is the result of the experience of an operator unequaled in point of number of operations performed in the world today, should entitle it to a respectful hearing.

Vail has published statistics showing the different kinds of cataract cases which presented themselves on a single morning at the hospital for cataract operation. These were:

Mature cataract	48
Immature cataract	23
Hypermature cataract	18
Couched (dislocated)	3

Capsular cataract	2
Black cataract	2
Juvenile or congenital	2
Other cataracts	2
	100

Gibney states that fully one-third of the operations performed in India are cataract extractions.



Intracapsular Extraction. Smith's Original Instruments About Twenty Years Old. 1, Curette or Spoon; 2, Delivery Hook; 3, Lid Hook.

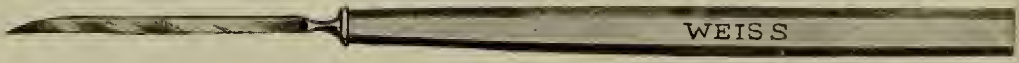
During the fall of 1909, most of which I spent at Jullundur, about 1,200 extractions in the capsule were done by Smith himself, Diwan Ali, his native assistant, Clark, of Columbus, Vail, of Cincinnati, and myself. Many of these operations, other than my own, I witnessed and followed through the after-treatment.

The Jullundur staff consisted of a native male and an English female assistant physician and surgeon, with seven native helpers, an operating-room clerk, an office clerk, one book and record keeper in the office, and four so-called dressers. He had for this large hospital about the amount of help required to run an operating room of a modern hospital in one of our large cities.

I have seen the new hospital crowded beyond its capacity with eye patients alone; yet it had 500 beds.

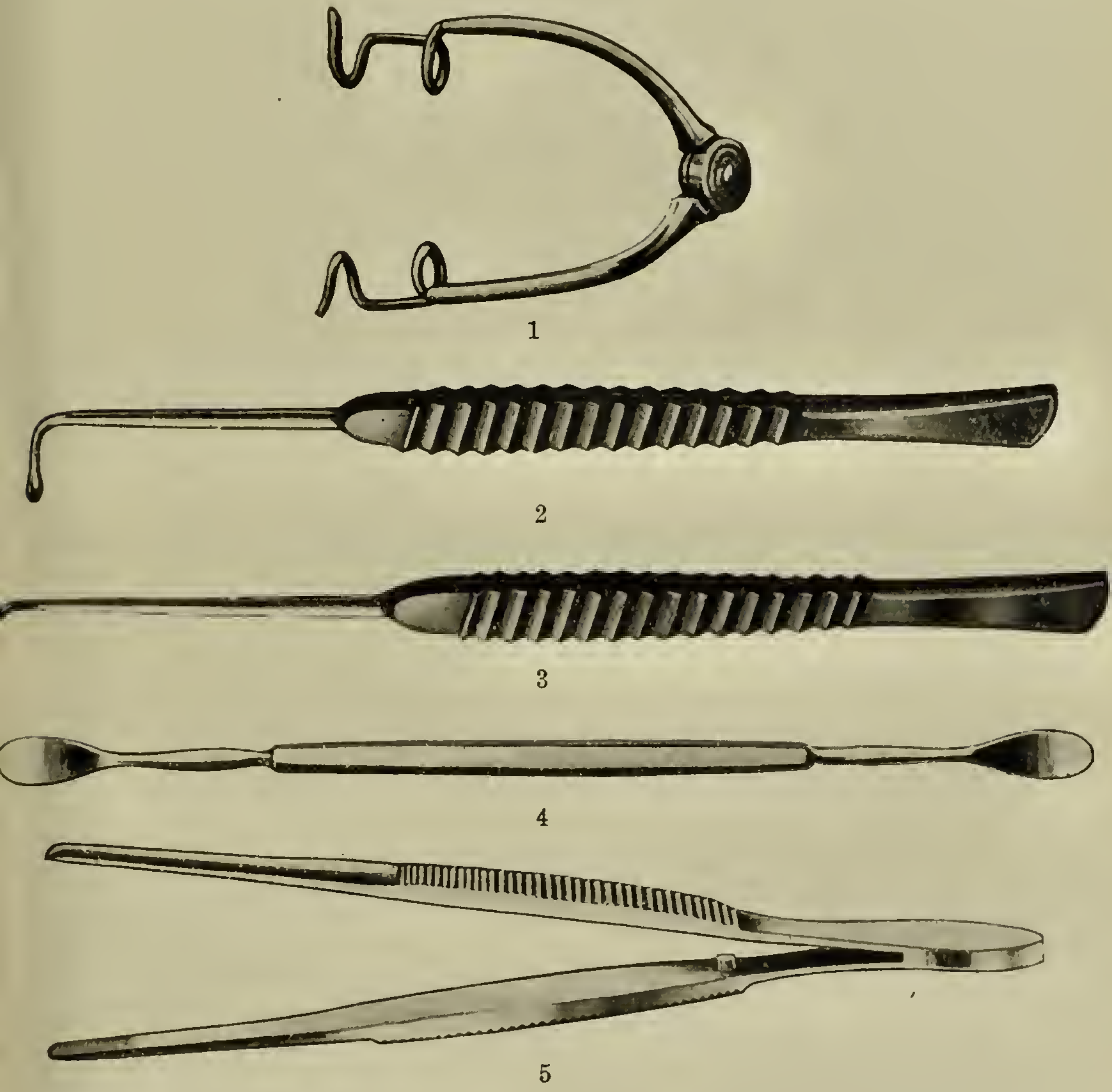
Of Smith's earliest operation of fourteen years ago little remains save the original principles on which it was based. The section has been changed from his early one (a slightly modified Lebrun) to the incision described by McKechnie. The instruments employed have been modified and the manipulation with the expression hook and the spatula, and the direction of the pressure on the cornea and lens, have also undergone change.

In the operating room the three tables faced a large window on the west. This position is of great importance to Mohammedan patients, who in their five daily prayers and other acts of worship always face toward Mecca. The Hindus are densely ignorant and deeply religious, and the attitude of worship (folded hands and eyes turned upward), is as natural to them as to breathe; and the same is true of Mohammedans. Many of them seem to pass into an auto-hypnotic state while being prepared for operation. If not spoken to or aroused they will go through an operation without a motion or a murmur, but if spoken to (as in directing them to look up or down) the spell is broken and they are not such good patients afterward. Fortunately their usual attitude Smith has found to be the best for easy and smooth delivery of the lens with a minimum loss of vitreous. It is the position the eyes naturally take in the relaxation of sleep, or under the influence of an anesthetic; it may, therefore, be called the position of rest in which muscular compression of the globe is practically nil.



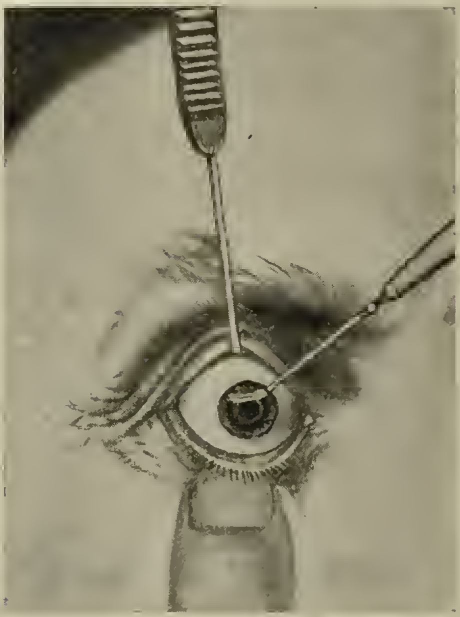
Intracapsular Extraction of Cataract. Modified Graefe Knife, with Straight Cutting Edge.

Technique of the Smith-Indian operation. The patient is prepared by the instillation of two drops of a 5 per cent. solution of cocaine, five minutes apart. The eyelids are washed with soap and hot water, a small silver speculum, with a weak spring and without a set screw, being in position, the outer one-third of the eye lashes is clipped off as closely as possible, so that the knife in making the corneal section cannot possibly touch the lashes. If at any time an instrument intended to enter the eye touches anything other than the eye-ball, it is immediately sent to the sterilizer. Then the eye-lids are lifted straight away from the globe by raising the speculum. The assistant now flushes the whole conjunctival sac with the one to two thousand bichloride solution held in a five-gallon glass container suspended from the ceiling. The flushing is done thoroughly and about four ounces of the solution is used as a rule, but if the condition of the conjunctiva requires it, more is used. This is left in the conjunctival sac for a short time, and then drawn off by turning the head of the patient to one side and making slight pressure at the outer angle with the thumb. The hands of the operator are washed with soap and hot water before beginning the day's work. After that all washing of the hands is with the bichloride solution. The rather severe antisepsis of the ocular field seems necessary since seventy-five per cent. of the cataract cases which came to operation at Jullunder had trachoma in some of its late stages, according to Smith's estimate. Many of the eyes I saw operated on with no other preparation than washing the side of the face and eyelids and the bichloride flushing above referred to, would be refused operation without preparatory treatment at any eye hospital in America with



Instruments Employed by Smith in his Operation for Intracapsular Extraction. 1, Speculum; 2, Lid Hook; 3, Expression (delivery) Hook; 4, Double-ended Spatula; 5, Broad Forceps for Extraction of Ruptured Capsule.

which I am acquainted. Notwithstanding the scant preparatory treatment, I saw only five cases of post-operative infection in about 1,200 operations, and only a small percentage of iritis and iridocyclitis, a record remarkable among a people who are dirty and filthy to a degree seldom seen in this country. While I do not use bichloride solution as a rule in operations at home, I am satisfied from my experience and from that of several Indian Medical Service officers with whom I discussed the subject, that for the diseased and germ-harboring conjunctival sacs of the natives, 1 to 2,000 bichloride solution freely used inhibits the development of germs and secures immunity from post-operative infection which could not be secured in any other way. It seems to be more important that it should be used liberally rather than that the strength should be increased above 1 to 2,000. This solution, which would be badly borne by normal conjunctivas in America, seems not painful to the diseased conjunctiva of East Indians.


Intracapsular Extraction. Smith's Toilette. (Greene.)

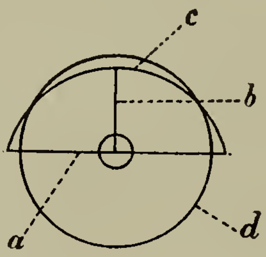
The instruments are carefully and thoroughly sterilized.

Smith thus describes the steps of his own operation: "Children and juveniles alone are not admissible because it is almost impossible to dislocate their lenses. The eye being prepared (atropine is not necessary) and the spring speculum inserted, the eye is fixed with special forceps, the Graefe's knife is inserted in the sclero-cornea and makes its counter-puncture in the sclero-cornea of the opposite side;

the incision is half or nearly half the circumference of the sclero-cornea. The knife is driven through to the heel, the handle being lowered as it goes through so as to elevate the point to avoid the nose or eyelid. It is used after it makes the counter-puncture to cut as it goes through. If it is a new knife and in good order, the incision should be completed with this thrust. If not completed a single draw-back should complete it without any sawing. We have thus an ideally clean cut wound. This incision I finish in the cornea and make with a sweep so that the edges of the corneal wound will be cut as nearly as possible at a right angle to the surface and not be obliquely sliced, which latter facilitates over-riding and which is the cause of a good deal of unnecessary astigmatism. An iridectomy may or may not be done according to the fancy of the operator, but my advice to a beginner is to do an iridectomy. There is probably a little more liability to incarceration of the iris in this operation than in the capsulotomy operation and incarcerations are more liable to occur where there has been escape of vitreous than where there has not; hence, I advise beginners to do an iridectomy. Incarcerations of the iris in this operation have a distinct connection with meddlesome dressing and meddlesome inspection. These cases, without some special indication, should not be dressed or inspected earlier than the expiration of eight clear days or even ten clear days from the time of operation, when no further dressing will be required.

"In this operation the novice owes most of his failures and most of his difficulties to not making a sufficiently large wound, and wherein his wound fails most is that it lacks in depth towards the sclerotic. Capsules bursting are very largely due to this cause.

"When the incision is finished and the iridectomy performed (if the operator decides to do one) the speculum is removed, and the operator proceeds without speaking to the patient. In the case of an immature lens or of a hard cataract, with a spatula in the operator's left hand ready for use if required, he proceeds to press back with the point of a strabismus hook towards the optic nerve, the point of the hook being placed over the lower third of the cornea. The pressure is steady and the point of the hook should not be moved until the upper edge of the lens tilts forwards and is thus seen to be dislocated, having been made to swing round on its transverse axis. The moment the lens is seen to be dislocated, the pressure through the point of the hook is gradually turned more and more towards the wound, pressure being maintained all the time so as to keep the lens up to the sclerotic margin, the pressure with the hook becoming gradually lighter and lighter and the hook gradually sliding after the lens until the cornea is folded beneath it. At this stage it is delivered. In a low tension eye the beginner should follow up the lens with the spatula in addition to the hook, as with it he can maintain a sufficient tension in the eye and thus allow his right hand instrument to follow up the lens more lightly. In rare cases of low tension eyes he might find it advantageous when the lens is half way out to apply a little counter-pressure above the wound with the spatula. In the case of intumescent lenses and Morgagnian cataract (in which the nucleus is small and is surrounded by a considerable amount of soft disintegrated lens matter) the capsule is generally extremely delicate and if dislocated in the manner above described, is liable to burst when the lens is half way out, allowing the nucleus to escape and to be itself retracted with considerable amount of lens matter. The operator is then placed in a difficult position, the capsule being dislocated at the wound. To overcome this I observed that lenses of this class occasionally turn a half somersault, dislocating into the wound, and that having done so, the capsule very seldom burst and when it did burst it was attached only in the neighborhood of the wound and was not drawn back, and that under these conditions it was very easily caught with a pair of dissecting forceps and removed entire without inserting any instrument into the eye. I proceeded to imitate this accident with this class of cataracts, first by applying pressure over the ciliary region, but soon desisted as I had a few cases of expulsive hemorrhage from choroidal detachment, which I attributed to my manipulation of this region. I then commenced to press with the point of the strabismus hook sufficiently deep over the lower border of the lens. I then found I could almost invariably make these lenses dislocate below and then turn a half somersault. This pressure and traction are always over the zonule.



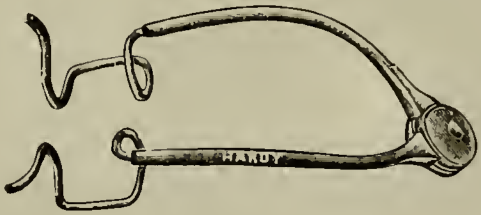
Cataract Extraction in the Unruptured Capsule. Smith-Indian Section. The Relations of, a, the Base Line; of the, c, Average Section (14 mm.) to the, b, Height of the Incision (5 mm.) and the Corneal Diameter (12 mm.); d, Limbus Corneæ. (After Greene.)

"As soon as the lens turns up into the wound, showing that it is freely dislocated below, the operator should cease to make traction toward the patient's feet but make direct pressure backwards, then backwards and upwards and, finally, more and more towards the wound, folding the cornea beneath the lens until it falls on the outside of the cornea. At this stage the capsule has not been dislocated from the zonula in the neighborhood of the wound. The hollow of the curve of the strabismus hook should now be made to sweep along between the lens and the wound to complete the detachment. The beginner, while using the hook thus, would do well in all instances to put the spatula on the cornea so as to keep up sufficient tension in the eye and so prevent the lens from slipping back into the eye in this later stage whether it be of hard or of soft consistency, since a lens is occasionally liable in this late stage to slip back into the eye and then to be exceedingly difficult to remove.

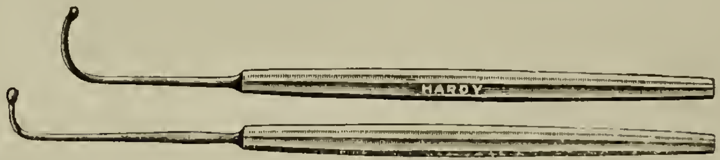
''The hypermature cataract is, of all cataracts the most difficult to dislocate. It has become shrunken, its capsule thickened, and its attachments have become firmer than is the case with any other senile cataract. The operator in this case should proceed with the strabismus hook as in the case of immature and hard cataract. The spatula in his left hand should be in position at the margin of the wound to drop behind the lens the instant the edge of it is seen at the wound, as otherwise pressure on the cornea will only squeeze out vitreous, the lens refusing to move. It should be dropped almost straight down into the eye, the back of it being kept throughout against the sclerotic margin of the wound. The lens should be pressed against it with the hook from the outside and thus made to slide up along the inclined plane of the spatula. The spatula should be kept steady in position, care being taken to not use it as a means of lifting out the lens. If used to lift out the lens, the capsule is very liable to be ruptured and vitreous escape behind it at the same time. It does not require to be inserted behind the lens to more than a trifling distance; it is thus used to prevent the pressure from the hook on the outside from putting objectionable pressure on the vitreous. The spatula for this purpose should have a slight curve and be about 7/16 inch broad and not sharp anywhere, so as to avoid the risk of injury to the capsule. A dextrous operator, if he follows these directions and the patient being fairly well behaved, will be able to extract hypermature cataracts thus with escape of vitreous in a trifling percentage of cases. I believe that hypermature cataract is infinitely more common in India than in America or Europe, as in those countries patients have their cataracts extracted before they reach this advanced stage.

"There is one other variety of cataract worthy of mention. It is a rare form, the color of coarse white soap, a characteristic color when once seen. It is exceedingly difficult to dislocate and when recognized the operator should proceed as in the case of hypermature cataract."

Reposition of the iris in the Smith-Indian operation. "The iris being a sticky membrane, is found, after the lens is extracted in capsule, sticking to the sclerotic and in the angles of the wound. Whether an iridectomy has been done or not its careful reposition in this operation is of the utmost importance. The assistant firmly holding up the eyelids and brow as before, it will be observed that the cornea drops back and that the iris, not in the neighborhood of the wound, falls on the vitreous leaving the aqueous chamber and the space which the lens occupied vacant. With a suitable repositor the operator should release the remaining parts of the iris from the sclerotic and from the angles of the wound. When this is properly done the operator is able to see back to the very base of the iris all round in the neighborhood of the wound. There need be no hurry about the reposition of the iris. It can and should be done with the utmost care. If this is done and the eye carefully dressed and not redressed until after the eighth day, and the patient behaves sensibly, iris prolapse will seldom be seen. Complications of the iris in the wound are generally due to not replacing it properly and to meddlesome dressings and meddlesome inspections and foolish conduct on part of the patient.



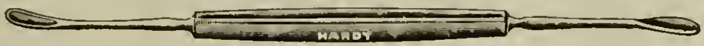
Jullundur Speculum.



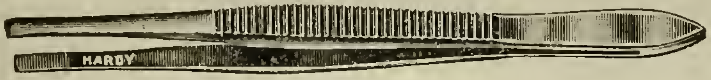
Large Lid and Small Extraction Hooks.

"If vitreous escapes it should be snipped off with scissors and not left hanging in the wound where it will act as a drain, preventing union. As iritis, iridocylitis and sepsis are so exceedingly rare following this operation, the after treatment is almost nil. Atropine is not necessary."

Arnold Knapp, after a visit to Major Smith's clinic in Jullundur in 1906 practically confirmed Smith's statistics. In "2,616 operations he had 6.8 per cent. loss of vitreous, and 0.3 per cent. of iritis in 2,494 operations when the lens came away whole. When the capsule was opened intentionally or was ruptured in delivery, iritis was observed in five per cent. of the cases." I myself am able to confirm the substantial accuracy of Smith's statistics, and, for the purpose of comparison call attention to Ring's collected statistics of 1,032 operations by the usual methods that furnished 7.32 per cent vitreous loss, 4.32 prolapse and 13.15 iritis.

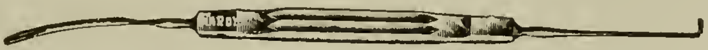


Double Spatula for the Smith-Indian Intracapsular Extraction.



Capsule Forceps, Smith-Indian Cataract Extraction.

The instruments employed in the Smith-Indian intracapsular operation. The speculum is a small silver instrument with a spring only sufficiently strong to hold the eyelids apart. It readily yields to the pressure of the lids if the patient "squeezes," as it is not supplied with a stop, or set, screw. The parts intended to receive the margin of the lids are deeper than in the ordinary speculum, which is a great advantage, as this admits of lifting the lids away from the eyeball for thorough flushing of the conjunctival sac. It seems to be practically the Clark speculum.



Iris Repositor for the Intracapsular Operation.

The two (so-called) strabismus hooks should be made of silver; the larger, called the lid hook, is used for elevating and drawing out the upper lid. It resembles a very large strabismus hook and is original with Smith; at least I have found no reference to it elsewhere. This hook, 5 inches long, because of its small bearing surface, bends the lid to an angle which breaks the power of the orbicularis, and prevents the patient from squeezing the lids together. My assistant, Millette, prefers a square handle, and the hook in line with one of its corners. Smith's hook is far superior to any other lid elevator for the purpose for which it was intended.

The expression hook, of silver, brass or iron, is much smaller than the lid hook. It should have a smooth bulbous tip, so that on contact with the cornea it will not abrade the epithelial layer. A nickel-plated instrument is unfit for this purpose; it slips too easily on the cornea. The curve from the bulbous tip to the shank of the instrument I have had made shorter than the original because, first, it is easier to manipulate on the lower border of the cornea in expressing the lens and, second, if it is necessary to use it in drawing the almost delivered lens out of the incision it is less in the way (in working under the lid) than the longer tip.

The double-ended spatula should also be made of silver, and five inches long, of which two and one-half are handle. It terminates in two flat ends, 6x12 mm. It has no close resemblance to a scoop or spoon and is not intended to be used as such, but rather as a gliding plane for delivery of the lens under the conditions described by Col. Smith.

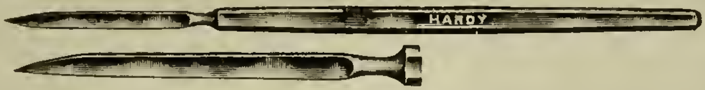
A medium sized, anatomic forceps completes the list of original Smith instruments. It has a broad, blunt tip, 1/8 to 3/16 of an inch wide, so that if the capsule ruptures it can be extracted in the majority of cases by pressing lightly on the upper or posterior lip of the section, and the other tip can be used on the lower or anterior lip of the section to coax the capsule out into the section where it may be caught and extracted. This is especially true if the lens has turned over and a portion of the capsule is hanging out of the wound. In fact, this is one of the advantages of turning the cataract over.

The iris repositor I use is a modification of the Knapp instrument, the probe end of which I have bent to a right angle 2 to 3 mm. from the shaft. I make some claim for the suggestion and for a later modification of the repositor, which in my hands has greatly improved its usefulness. The shape is about the same, but the probe-point has been made thinner and sharp. When I fail to replace the iris satisfactorily with the flat end, the sharp end has many times served a good purpose.

The fixation forceps has 4 or 5 mouse-teeth to each blade which should angle slightly forward, and interlock. This construction insures a deep and firm hold, therefore good control of the eyeball without tearing the conjunctiva. If the eye is small and deeply set, it is possible *with such forceps* to draw the globe from the depths of the socket and turn it so that in finishing the section the point of the knife can be directed over the bridge of the nose without pricking it or the lids. I have observed in many cases with shallow anterior chambers that this act of lifting or drawing the eyeball out of the depths of the orbit, causes the anterior chamber to deepen and the knife can be passed through without injury to the iris.

Intracapsular Cataract Extraction. Greene's Modification of Knapp's Iris Repositor.

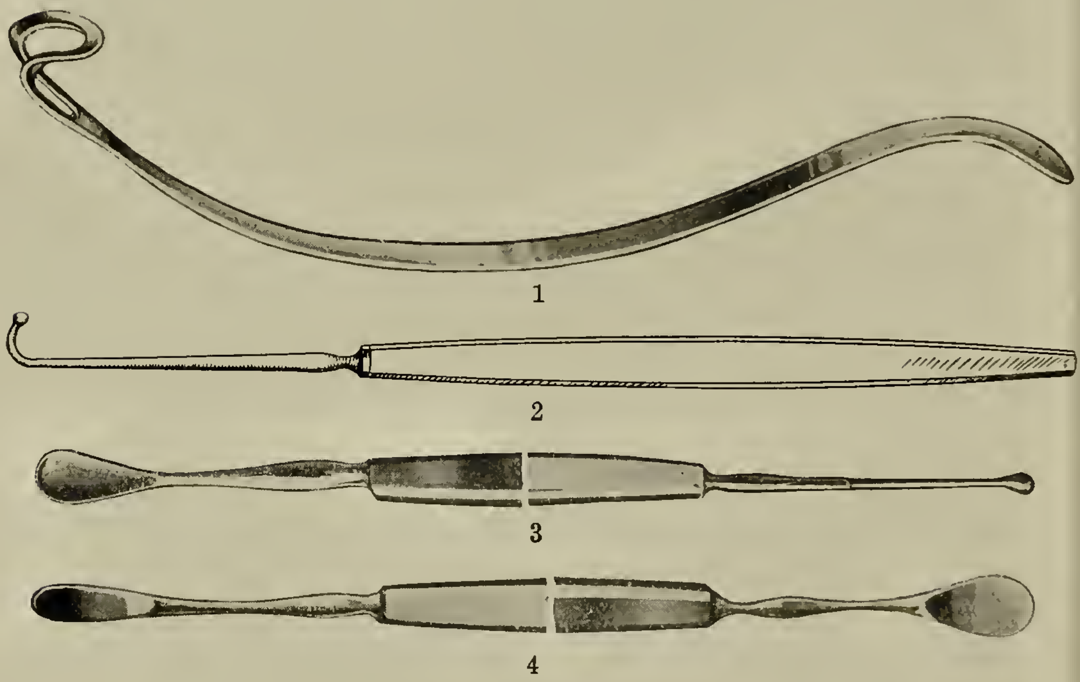
A new Graefe knife, 30 millimetres or even less in length, will answer in the hands of an expert, but for the average operator, a longer and wider blade has many advantages. Such a blade should not be less than 32 millimetres in length and a trifle less than 3 mm. wide. It ought to have the well known bayonet point, or a straight cutting edge, and a scimitar point made entirely from the back. I have had some credit for devising this shape of blade, but I have found the design much older than I thought. For example, Thompson, of Indianapolis, showed a knife of the same general design at the 1910 meeting of the American Medical Association which he has used for eighteen years. Ziegler, of Philadelphia, has also used practically the same knife, which he purchased in Paris many years ago.



Cataract Knife for the Intracapsular Operation.

The author's method of intracapsular extraction. The assistant, a most important factor in the operation, should take his place on the left side of the patient for either eye. If he prefers he may sit down. He should take the large Smith lid hook between his thumb and index finger and insert it under the upper eyelid and make gentle traction outward in line with the axis of the orbit, the patient lying on his back. When this has been done he should drop his middle, ring, and index finger on the patient's supra-orbital ridge and push directly away from himself: that is, towards the top of the patient's head to prevent him from squeezing. His elbow should be elevated so that there will be room for the surgeon to use his left hand and arm—as will be explained later.

The duties of the assistant require a thorough knowledge of the principles and technic of the operation, as well as of the accidents that may happen during its performance. A good assistant is not made in a day, nor in many days. He should take off all pressure from the eyeball, and expose as much of the field of operation as may be necessary for the manipulations of the surgeon. If a speculum is introduced he has nothing to do until the section and iridectomy are made. If, as the author prefers, the Fisher lid elevator is used, when the section and iridectomy are made, the assistant elevates the upper lid with it, and draws down the lower lid with (a piece of gauze under) his left thumb.

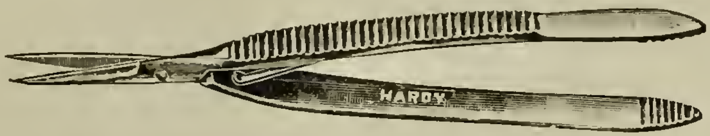


Instruments Employed in Author's Intracapsular Extraction. 1, Fisher's Lid Elevator; 2, Greene's Modification of Smith's Delivery Hook; 3, 4, Greene's Modifications of Smith's Spatula.

Before leaving this subject I desire again to call attention to the perfect control the assistant has over the orbicularis muscle with the large Smith hook under the upper lid.

In intracapsular extraction there are a number of details which should be carefully studied and worked out by the prospective operator. The section should always be ample, the iridectomy of medium size, and the manipulations, particularly the pressure-manipulation, should never be excessive or prolonged, and never made over the center of the cornea.

I make it a rule to explain and make clear to every patient that three things are required of him during the operation. First, he must look straight ahead, or slightly downward, during the section and iridectomy; second, he should look as high up as he can, without effort, during the extraction of the cataract and making the toilette, and third, he must under no circumstances look down after the operation is over, and the eye has been bandaged. Indeed, these instructions might be simplified by telling the patient to direct his gaze straight at the ceiling, and continue to keep it fixed in that or the corresponding direction, until he is placed in bed.



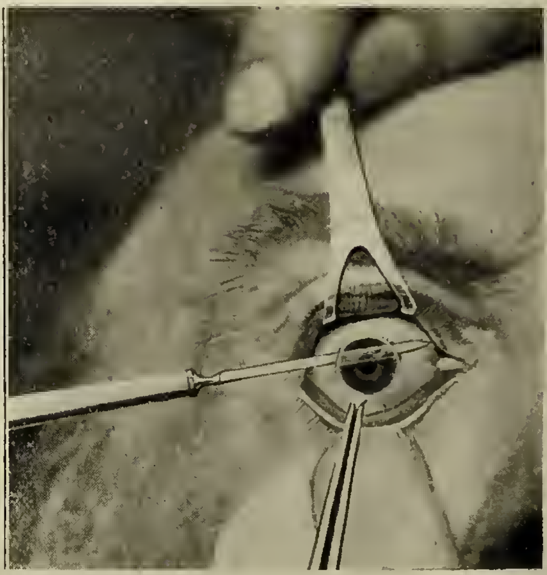
Scissors for the Intracapsular Cataract Operation.

This is the most important assistance the patient can give the operator. I believe that the patient's looking quickly and forcibly down, in spite of explicit directions to continue his gaze directly upwards has been responsible for more than a third of my cases of vitreous loss after the delivery of the lens. Assuming, however, that one has a skilled assistant, trained to watch the progress of the operation, and able to anticipate and meet emergencies, loss of vitreous need not take place in more than ten per cent. of all cases—outside of India.

When everything is ready for the extraction of the lens, the operator should take his place on the right side of the patient for either eye, standing far enough down along his side so that by stooping or, if he prefers, sitting, he may always have a good view under the upper lid and see the whole length of the section—whose condition is the best guide the operator can have as to how the lens will present and be delivered.

The section in capsulo-lenticular extraction. The idiom, "la section, c'est l'opération," generally applied to other forms of extraction, is especially true of extraction in the capsule.

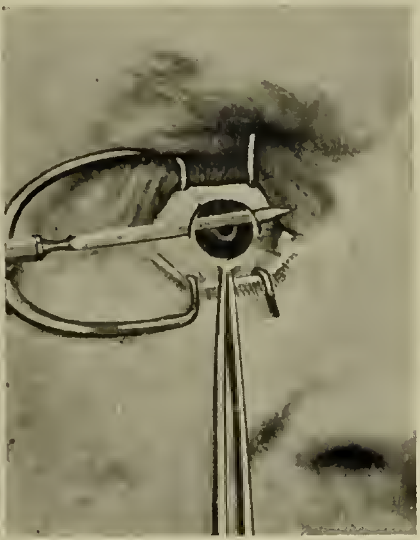
As has been stated, the lens in its capsule cannot be delivered without a large section. To make the Jullundur section properly the knife should be held in the right hand when operating on either eye, the point should be entered 2 mm. behind the transparent margin of the cornea and be directed toward the center of the pupil; the knife held at an angle of about 20 degrees above the horizontal plane of the iris. With the knife held at this angle the point will cross the chamber and not pick up the iris, as is likely to happen if the blade passes across with its edge parallel to the iris. For making the section of the right eye the operator should stand behind and a little to the right of the patient. For the left eye he should stand a little to the left and rather in front of the patient. The end of the handle of the knife should touch the third phalanx of the index finger, but should be so lightly held far out on the handle that the end can drop into the space between the base of this finger and the thumb. In this case it can be manipulated and rotated between the fingers and thumb with a freedom not possible by the ordinary method. The little finger should rest on the patient's temple to steady the hand of the operator, so that the section can be completed by the finger or at most a very little wrist motion.



Intracapsular Extraction. Smith-Indian Method, with Fisher Lid Elevator. Corneal Incision. (Greene.)

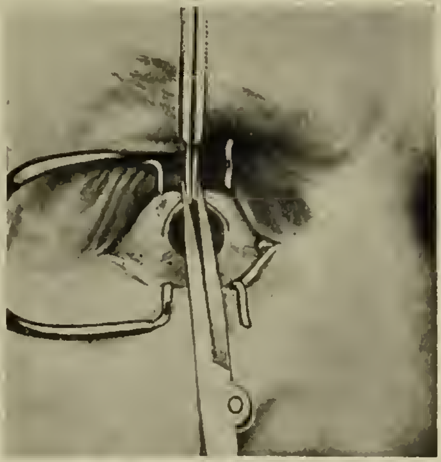
The puncture and counter-puncture should be made as far back in the angle as "anatomy and experience teach us to go, without wounding important structures"; about 2 mm. is a fair average. The knife should cross the chamber with its back level with the center of the undilated pupil.

The chief fault of the large section is that it is likely to lack in depth at the inner angle where in my judgment, it should be as deep as at the outer angle. With a curved sweep upward, cutting from point to heel, the knife should emerge in the cornea about 2 mm. from the limbus, and at a right angle to its surface. This will give a shoulder to the section intended to prevent over-riding of the flaps and a high degree of astigmatism.



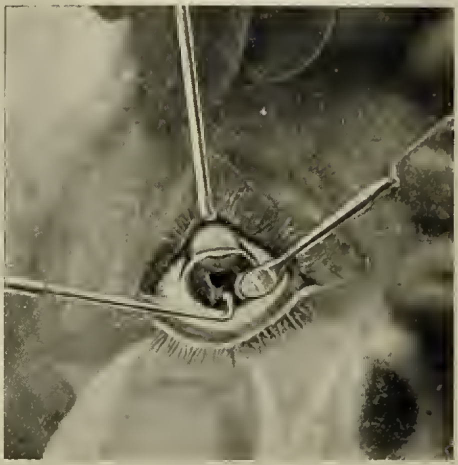
Intracapsular Extraction. Smith-Indian Corneal Section. (Greene.)

It will be observed that this section is almost entirely corneal and has all the advantages and disadvantages of a section so located. One of the chief advantages is that in a 12-millimetre cornea it gives plenty of room for the largest lens to pass through. Another, and



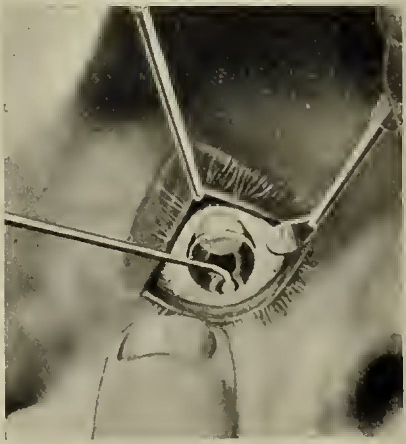
Intracapsular Extraction. The Iridectomy. (Greene.)

perhaps the most important advantage is that it is located just right to receive the emerging lens as it is tilted forward in delivery. Its greatest disadvantage is that it is placed so far away from the nutritive supply of the cornea. It resembles somewhat the Lebrun section, but is more nearly a Liebreich made upward, not downward.



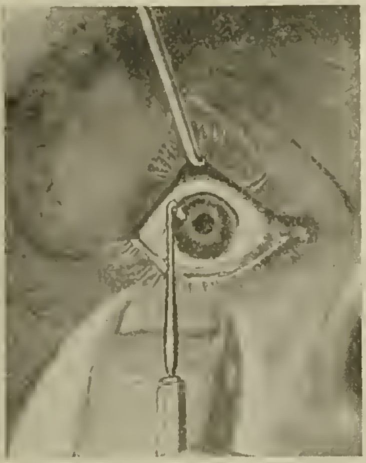
Intracapsular Cataract Extraction. Smith-Indian Method. Straight Delivery of The Lens. (Greene.)

The average American cornea I have found in 600 old soldiers to measure about 11¾ mm. in its horizontal diameter, and the average cataract in the capsule to measure about 8¾ mm. I judge from these facts that both the puncture and counter-puncture should be at least two millimetres outside of the cornea so that the base line of the section should measure about 14 mm., which will coincide with



Intracapsular Extraction. Smith-Indian Method. "Tumbler" Delivery of The Lens. (Greene.)

the greatest horizontal diameter of the cornea. For any cataract of the usual size, the section should have the dimensions given above, and if the cornea measures less than 9½ millimetres in its horizontal diameter, the operation is contraindicated, because the diameter of the lens and that of the cornea too nearly coincide and the lens could not be delivered without exerting dangerous pressure on the eyeball.



Intracapsular Extraction. Modifications of Corneal Incision and Toilette. [The iridectomy should have been shown in this illustration.] (Greene.)

With every plane of the section parallel to every other plane close coaptation of the lips of the wound and prompt healing should be the rule. There should be no "stair-steps," or "saw-teeth" in the section such as are observed when the knife is made to saw through the cornea by to-and-fro motions.

I have not from the beginning been entirely satisfied with the Jullundur section either in India or at home in persons over seventy years of age. Something of course depends on their physical condition. Some persons are physically older at seventy than others at eighty. I have gradually returned to the circular marginal section for this class of cases which was used before going to India. Admitting the advantages of the favorable location of the Jullundur section for easy delivery of the cataract, and affirming that cystoid healing does not occur in a pure corneal section and accepting the statement of those who contend that the over-hanging ledge of cornea in the posterior lip of the section is a protection against vitreous loss —admitting these great advantages—we must not forget that as an incision is made further out in the cornea we take it away from the nutritive circulation at the limbus, therefore it is a question to what extent the healing of this section may be influenced by its location.

We also know that for some reasons all low corneal sections have heretofore been short-lived, e. g., the Liebreich and the Lebrun.

The circular marginal section, which I advise in patients around and above 70 years of age, is pratically the same as the original Daviel section. It should, however, involve only one-half of the cornea. It should be made upward and should lie in the limbus, where nutrition is better than out in the cornea. Among modern incisions the nearest approach to it is Santerelli's; or perhaps an enlarged de Wecker would give a better idea of its size and location. See for a description of these, **Cataract, Senile.**

I have observed that my most frequent troubles after operation by the Jullundur section relate to the healing of the wound, and incidentally to conditions which ought not occur if the nutritive material for closing the section were promptly furnished. Old people do not seem able to furnish this with uniformity. My statistics show that in using this section (before going to India), I had fewer cases of delayed healing and lower degrees of astigmatism. I have come to the conclusion that the disadvantages of the large Jullundur incision are, first, its location in the cornea seems to delay healing in very old people, as just stated. Second, it seems because of its size not to heal so firmly and solidly in a given number of days as the regular incision. Third, having apparently healed, it will sometimes reopen either from intraocular pressure or from external injury. I have also seen it occur several times from straining at stool. Fourth, I have seen the section remain open for five weeks before closing solidly. These, also, are the cases so likely to be complicated by prolapse or incarceration of iris, kerato-iritis, and high degrees of astigmatism. Trouble is likely to follow if a cataract section does not close within forty-eight hours. Delayed healing is not so likely to occur if the section is clean cut, and the flaps are closely coapted and no tags of zonula or other obstructions to healing are left in the wound. Epithelial layer should be united with epithelial layer, Bowman's membrane with Bowman's membrane, substantia propria with substantia propria, etc. Such perfect primary union was the rule at Jullundur, but in my American experience with the operation about 5 per cent. of patients around seventy years of age do not have this primary union. I have observed delayed closure of the section in the eye wards of the Hospital of the National Military Home, where the average age of the soldiers of the Civil and Mexican Wars was on June 30th, 1912, 70 years. The oldest was 97, the youngest 60.5 years; and these figures are based on 6,084 inmates.

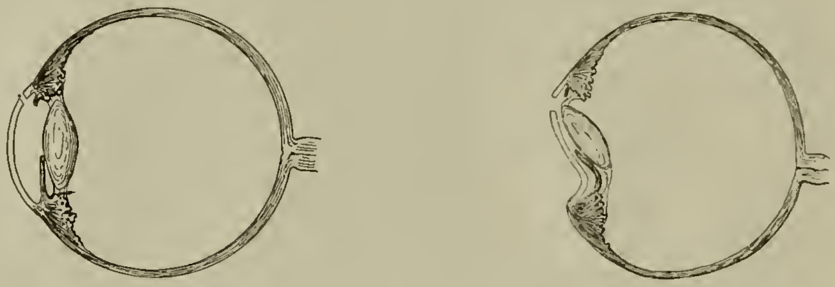
The section which McKechnie (On Incision of the Eye with Special Reference to Incision for the Extraction of Cataract, and for the Relief of Glaucoma. *Archives of Ophthal.*, Vol. XXXVIII, 1909, pp. 228-253) has so fully described was the one made in practically every operation at Jullundur. I have made the same section many times and found that it healed firmly in 183 of my Indian 354 cases on the fifth day. In America, for some reason it has not been so satisfactory and I have been led to search for an explanation in racial characteristics and the fact that the age of American cataract patients is greater than those operated on in India. I am not unmindful of the fact that I may not make the section now as well as under Smith's direction, but we should remember that our patients average about twenty years older than the East Indian's.

Hirschberg has shown that the average age of cataract patients in India is forty years; in Germany sixty-two years. Vail has estimated the average age of our patients at Jullundur at fifty-six years. Jackson, of Denver, has given the statistics of 1,545 persons over 50 years of age, patients in Wills' Eye Hospital, Philadelphia; 439, or 27.8 per cent., had some degree of lens opacity. Arranged in five-year periods, the per cent. showing such opacities was as follows: 15 per cent. between 50 and 55, 16.1 per cent. between 55 and 60, 30.2 per cent. between 60 and 65, and 77 per cent. between 65 and 75. Norris has given statistics of 584 inmates of the poorhouse, between 50 and 60 years of age, in whom 264, or 45 per cent. had traces of cataract.

The iridectomy in capsulo-lenticular extraction. The Jullundur method is as follows: One blade of the iris forceps held in the left hand was laid on the posterior lip of the wound and the other on the anterior lip of the wound, and by pressure downwards (more on the anterior than the posterior lip) the iris was made to prolapse, was caught as the forceps closed, and cut in the direction of the section by the scissors in the right hand. An advantage of such an iridectomy is that no instrument enters the anterior chamber.

While in Jullundur I was permitted, at my request, to make the iridectomy as I had made it for many years. viz: by passing the points of the forceps well inside the section (if necessary) and catching a small bit of iris and drawing it out and cutting it off from below upward. By pressing the scissors downward across the section a more peripheral (the important thing) iridectomy can be made.

There is in intracapsular extraction a stronger tendency to drawing up of the pupil than in the regular operation. I formerly believed this could in a measure be counteracted by a preliminary iridectomy, and I am now satisfied from further experience, that this is not true and in addition the inflammatory adhesions which form at the base of the pillars of the iris, *by preventing stretching of the coloboma,* render the delivery more difficult and increase the percentage of vitreous loss. It is, therefore, *not* an advantage in my opinion. My preference now is for a small iridectomy made as peripherally as possible at the time of the operation. While delivery may not be quite so easy as through a larger coloboma, this, in my opinion, is more than offset by the greater amount of iris left, the sphincteric action of which is a great aid in replacing and smoothing it out while making the toilette (so-called).



Smith-Indian Cataract Extraction.

Straight Delivery of the Lens in its Capsule. Section and iridectomy completed. Lens not disturbed.

Straight Delivery of the Lens in its Capsule. Tension put on the zonula below through the cornea and iris, with the point of the delivery hook, for dislocating the lens. Note the direction of this pressure backward toward the optic nerve.

Under the assumption that a sclerosing crystalline lens of the right eye in the incipient (immature) or mature stage of cataractous degeneration is to be delivered—when the section and iridectomy have been made, the operator should take his place on the right side of the patient *for either eye,* standing far enough down along his side, so that by stooping, or if he prefers, sitting, he can always have a good view under the upper lid and see the whole length of the section—the behavior of which is the best guide the operator can have as to how the lens will present and be delivered, and what manipulations are needed *to aid and not hinder delivery.* If, on making the initial pressure, the upper border of the lens presents well in the section, the lips of which closely engage it, the operator can judge with great accuracy that such a cataract will be delivered "straight." If, on the other hand, the upper border of the lens does not promptly present in the section, but the wound shows a marked tendency to gape and a wave-like motion is noticed, coming from below upward in the cornea, the operator may know with reasonable certainty that the cataract will turn over in delivery, and be a "tumbler." The kind, and especially the consistence, of a cataract largely determine in which of these ways it will be delivered.

The surgeon, after telling the patient to continue to *look straight up,* should pass his left hand (in which he holds the double-ended spatula) beneath the assistant's right hand and arm, and hold it perpendicular to the cornea, close to its lower border. He should hold the smaller delivery hooks in his right hand (for either eye), resting his third and fourth fingers on the patient's temple. He then makes light pressure, *with the point,* on the lower border of the lens, *backward toward the optic nerve.* It is not possible to describe in words the amount and direction of this initial pressure, except to say, in a general way, that it should never be excessive or mis-directed; one can only reach an appreciation of it by acquiring trained eyes and best of all, an educated tactile sense—"thinking fingers" (as Meding calls them).

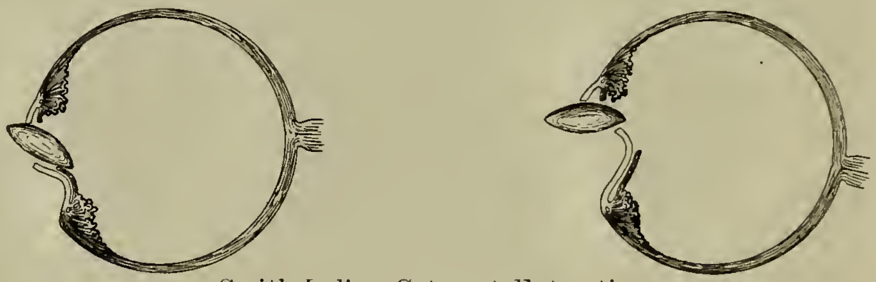
The purpose of this pressure is to *dislocate the cataract,* an entirely different series of manipulations being required to deliver it without accidents in a high percentage of cases, and these are difficult to describe. They should be learned at the elbow of a competent operator.

If the initial pressure does not dislocate the lens, the hook *should be laid flat* across the sclero-corneal junction below or, as is sometimes necessary, *on the sclerotic itself,* and the point directed upward toward the pupil. Light pressure should then be made directly backward with the side of the curved portion of the hook. This manœuvre is intended *to serve a double purpose with a single instrument,* (1) to put tension on the vitreous with the curved part and thus cause the lens to engage in the section and (2) to fold the cornea under the lens with the point and let it be delivered by closure of the section under it.

When the cataract does not dislocate easily, another method may be tried:—Make light pressure with the edge of one end of the spatula (held in the left hand) on the cornea at the limbus below, or on the sclerotic, in addition to pressure with the point of the delivery hook in the right hand on the lower rim of the lens. The object of this manipulation is to put tension on the vitreous to help dislocate the cataract and crowd its upper border into the incision, or to prevent it slipping back into the vitreous after it has been engaged in the section.

When, as a result of one or other of these procedures the position of the cataract has been changed from a horizontal to a perpendicular plane and it is standing about upright in the section it is *dislocated,* and the pressure backward with the spatula must instantly cease.

While the cataract may not be wholly delivered when in this position, its important connections are broken and the pressure made *with the point of the delivery hook must now be quickly changed to manipulations in the direction of the wound.* Many avoidable losses of vitreous occur at this stage of the delivery because the operator is not experienced in the manipulations in the direction of the wound. He continues *the pressure backward too long,* when all that is usually required to deliver the cataract without accident is to fold the cornea around or under it with the point of the hook, making a *phimosis,* so to speak. Sometimes when the cataract is well engaged in the section or almost wholly delivered it is better to slip the curved part of the delivery hook under its equator on either the temporal or nasal side. Then by slight traction it can be rolled edgewise through the section and delivered, rather than to manipulate further in the direction of the wound as described above. Seventy-one per cent. of the cataracts while I was at Jullundur were delivered "straight."



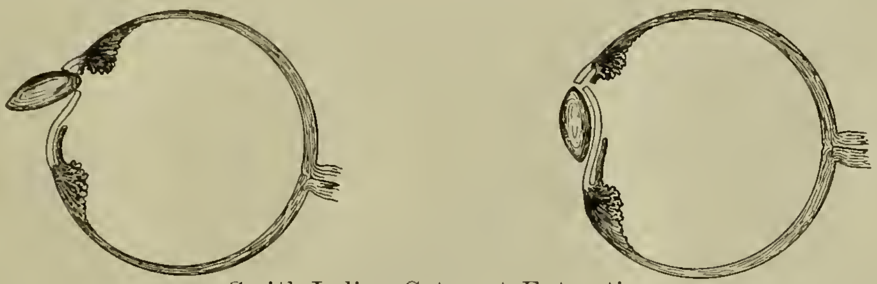
Smith-Indian Cataract Extraction.

Straight Delivery of the Lens in its Capsule. Position of the lens in the section after the zonula has given way from the pressure, as shown in the foregoing figure. The pressure is now up, towards the wound.

Straight Delivery of the Lens in its Capsule. Lens entirely dislocated. It now stands perpendicular to the section, which is the best possible evidence that it is dislocated, delivery being aided by folding the cornea under it, with very little pressure upward.

In extracting hypermature or small discoid cataracts it is sometimes necessary to make light pressure with the tip of the spatula on the posterior lip of the section, and in certain of these cases it is better to pass the broad end of the spatula (held at about a right angle to the wound) 2 to 3 mm. into the eye close under the posterior lip of the section, but not deep enough to rupture the hyaloid. The purpose of this procedure is to give a firm base against which the cataract will, under pressure and manipulation on the cornea below, impinge in its exit from the eye.

Suppose, furthermore, that an intumescent or any cataract with soft cortex and a small nucleus is to be delivered. The surgeon should place the delivery hook in about the same position as that described above but instead of pressing directly backward toward the optic nerve with the point of the instrument he should twist or turn the hook between his fingers until the bent portion stands perpendicular to the cornea, and then give it a further twist or turn until the point catches under the ciliary ridge (body). This, of course, requires some pressure, but as the point catches the operator will know it. He must continue to make light, steady pressure, not backwards, as in the former case, but directly downwards towards the patient's feet, away from the wound. The section will gape widely, this being evidence to the operator that he is dealing with a "tumbler." The zonula will give way below, and the intra-ocular tension will force the lower border of the lens forward; it will turn and be delivered quickly, provided it is *recognized as a tumbler*, and the manipulations employed are such as aid rather than *interfere with it turning over*.



Smith-Indian Cataract Extraction.

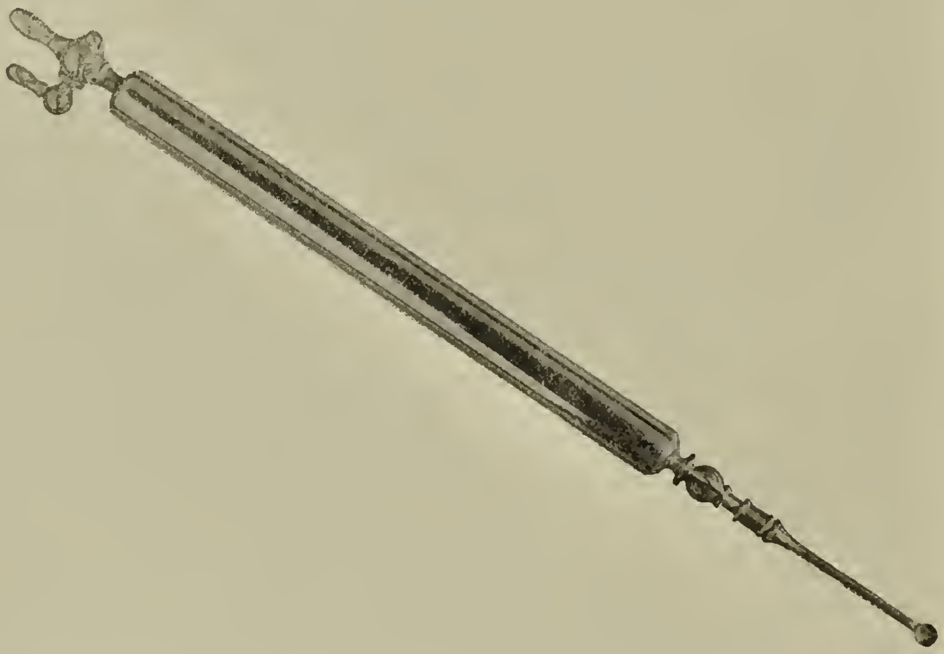
Straight Delivery of the Lens in its capsule. Lens dislocated and almost delivered, by the cornea being folded under it. In this stage of delivery the lens becomes top-heavy and tends to fall forward.

Straight Delivery of the Lens in its Capsule. Complete delivery of lens lying on its face with section closed behind it. Lens has been both dislocated and delivered.

These manipulations must be made slowly and with the utmost gentleness, otherwise vitreous may be lost, or the capsule will rupture. In this event it is often possible to catch it with forceps and draw it out if the operator is dextrous. Vitreous is seldom lost when the lens is delivered in this way.

Turn-over delivery of the lens in the Smith-Indian operation. Twenty-nine per cent. of cataracts delivered at Jullundur "turned over," the manipulations being deliberately directed to that end. Consequently, I believe Elschnig to be clearly wrong when he asserts that "the operator is not able to effect one or the other delivery in suitable cases."

A marked peculiarity of Indian eyes is a tendency to collapse or umbilication of the cornea after the cataract has been delivered. This condition is difficult to explain; it may be a racial peculiarity. My experience in dealing with these people surgically leads me to believe that they are comparatively free from arterio-sclerosis, high blood-pressure and high intra-ocular tension—conditions very frequently observed among American patients. Another theory is that East Indians carry so little superfluous fat that the usual cushion of adipose tissue behind the eyeball is largely absent, the eyeball hangs loosely in the orbit and tends to sink backwards and make the section gape. The tonometer should give valuable information in such cases. This condition is seldom seen in American eyes.



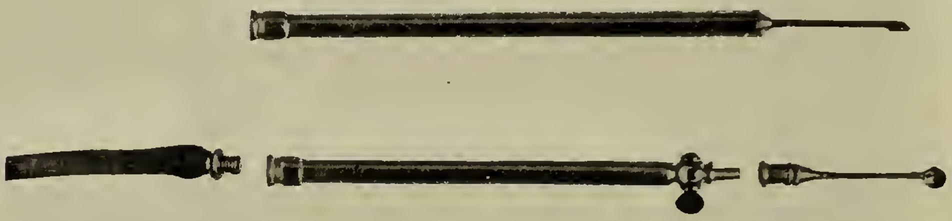
The Vard Hulen Intracapsular Cataract Extraction. Vacuum Extractor.

In 1910 Vard Hulen (*Ophthalmic Record*, Dec., 1910) reported a new operation for extraction of cataract in its capsule. Later he further described the method in a paper entitled "Vacuum Fixation of Lens and Flap Suture in the Extraction of Cataract in Its Capsule (*Trans. Oph. Sec. A. M. A.*, 1911, p. 122) and summarized the procedure as follows:—

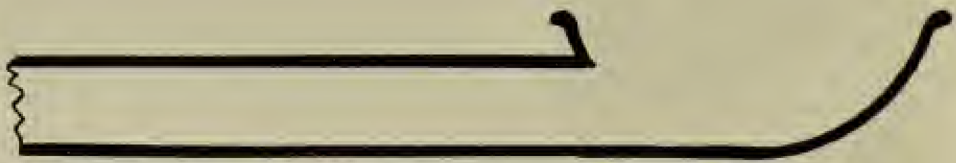
The usual preparation of the patient and eye with the preliminary dilatation of the pupil is made. Cocain and epinephrin are used for local anesthesia and blanching. The speculum is introduced and the section made in the limbus, which should include one-half of its circumference, and raise the conjunctiva above but stop short of severing the flap; a fine silk suture is introduced as shown in the figure. Then the bridge is cut with one snip of the scissors. The iridectomy is now performed if a preliminary one has not already been made; a preparatory iridectomy is, however, always desirable. The speculum is next removed and if blood in the anterior chamber obscures the pupil, it should be washed out with a gentle stream of warm saline solution. The assistant holds the upper lid with the lid hook and controls the lower with the thumb of his other hand. Under no circumstances must he permit pressure on the globe until the eye is finally closed; the patient at the same time should look straight ahead, *never down*. The cup of the vacuum extractor (see the figure) is introduced from the side through the section and gently placed on the anterior capsule over the center of the lens. If the pupillary margin is everywhere free the nurse is directed to turn the cock at the gauge. The vacuum cup will then grasp the cataract most rigidly. Now the lens should be slightly lifted and rotated on its antero-posterior axis to sever the suspensory ligament; then with the upper edge slightly advanced the cataract in its capsule is slowly and gently lifted through the pupil and section. The suture is immediately tied. Safe from the loss of vitreous, we may now replace the edges of the coloboma with the iris repositor (introducing it at each side of the knot) and perform the usual toilet of the eye without apprehension.

I saw Arnold Knapp perform an intracapsular operation a few years ago. The patient was an elderly woman; the cataract mature. He made a section which included one-half of the cornea. This was followed by a medium iridectomy. Then, with a pair of Kalt's capsule forceps he took a broad grasp of the capsule and dislocated the cataract by moving it in different directions and delivered it after the method of Col. Smith. I understand Knapp has been following this method of extraction in what he considers suitable cases since visiting Smith at Jullundur in 1905.

In addition to the reference to Stancleanu's method I must add that Simpson, of Memphis, presented a paper entitled: "Intracapsular Extraction of Cataract after the Method of Prof. Stancleanu of Bucharest" (*Trans. Am. Acad. Oph. and Oto-Laryng,* 1912), from which the following excerpts are taken: "The incision and counterpuncture are made well back in the limbus, thereby giving sufficient opening for any cataract to be removed without traumatism to the edges of the wound or posterior surface of the cornea. The ordinary iridectomy is now made (sometimes iritomy) after the method of Monalesco. The next step in the operation is the one in which this procedure differs so markedly from all other cataract extractions. It is through this procedure that a black pupil without secondary cataract is obtained, and at the same time the necessity for hard pressure. with its complications, is removed. This consists in the grasping of the anterior capsule of the lens by means of a capsule forceps. The forceps have no teeth to tear the capsule, and the capsule is grasped. not with the end of the forceps, but with the most prominent part of the curve. The forceps are introduced into the anterior chamber, closed and sideways, and after getting the instrument into the pupillary area it is opened perpendicular to the surface of the capsule, and by slight pressure backward a firm bite of the capsule is taken. Movements are now made from side to side and up and down, thereby rupturing the zonular attachments. The operator has the sensation that the lens is loose as the zonula is ruptured. The forceps are now opened and removed from the eye. About one to three firm steady movements in each direction is all that is neces-

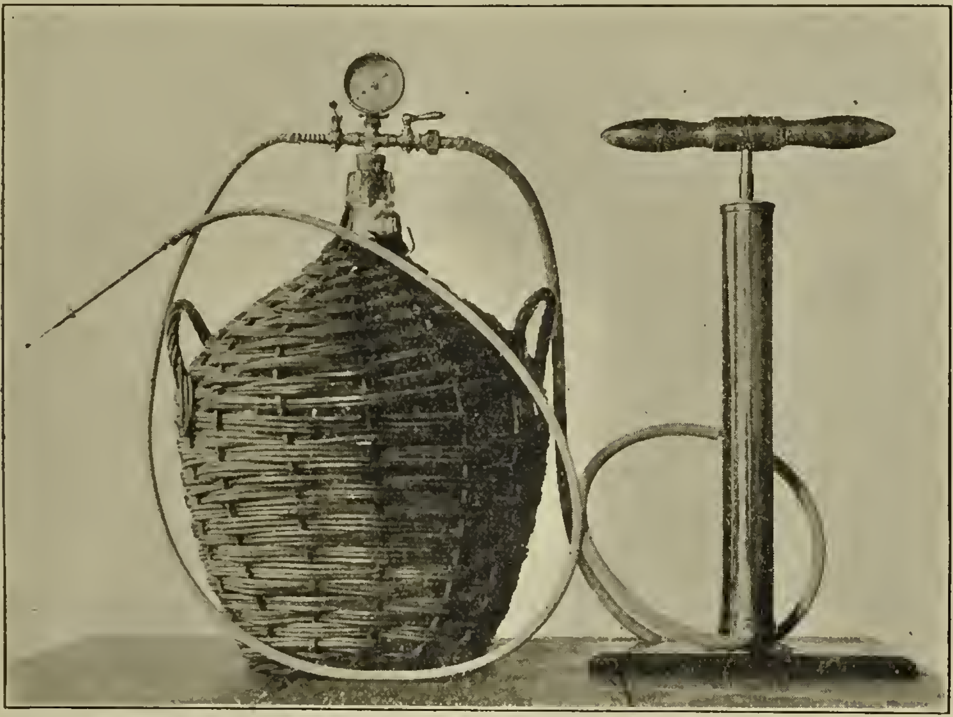


The Vard Hulen Intracapsular Cataract Extraction. Vacuum Extractor with Handle Disconnected. Vacuum Extractor, Side View.



The Vard Hulen Intracapsular Cataract Extraction. Vacuum Cup.

sary. After rupture of the zonular fibers by movement of the lens through this application of the capsule forceps to the anterior capsule, continuous pressure with a spoon over the cornea slightly below the center, with slight counter-pressure above the wound, is made. As the lens in the capsule comes through the incision, it is followed by the spoon from below As a general thing, without allowing the lids to close, the iris is replaced so as to limit as much as possible opening of the eye."



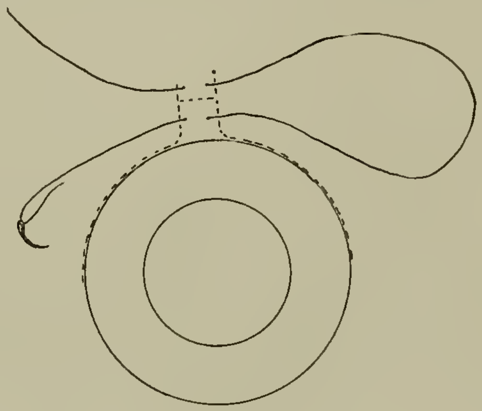
The Vard Hulen Intracapsular Cataract Extraction. The Vacuum Pump with Apparatus Attached.

I have had some experience (25 extractions) with the foregoing method and believe that the anterior capsule will be ruptured by the manipulations in about 50 per cent. of all cases of cataract. In the incipient and intumescent forms *as a rule* the capsule will not stand the necessary manipulations. I have lately modified both the Kalt and Stancleanu forceps by having the curved points made shorter and probe pointed; also the points made slightly divergent to avoid injury to the capsule. This, I think, has greatly increased their usefulness.

After dislocation of the cataract by this procedure delivery has been effected after the method of Smith, as already described. From limited experience, I believe the method has a field of usefulness.

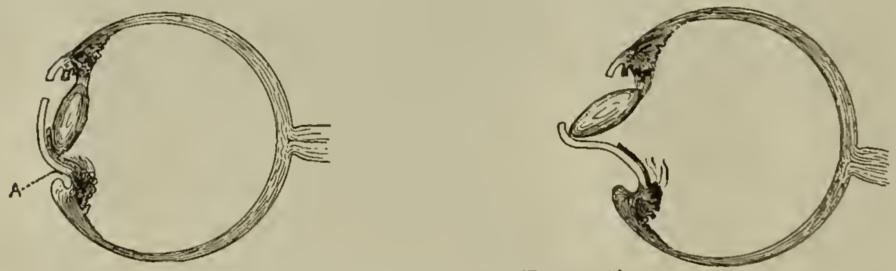
but it is much more restricted than that of the Smith-Indian operation.

Terson and Landesberg had this same idea as Staneleanu, but they seem to have delivered the cataract entirely with forceps; nor did they employ the method as a routine procedure.



The Vard Hulen Intracapsular Cataract Extraction. Suture to Close the Section.

The Jullundur toilet. The toilet of eyes operated on at Jullundur was very simple. It consisted in freeing the iris angles of blood and tags of capsule (if ruptured) and smoothing out the pillars with the point of the hook with which the lens had been expressed.

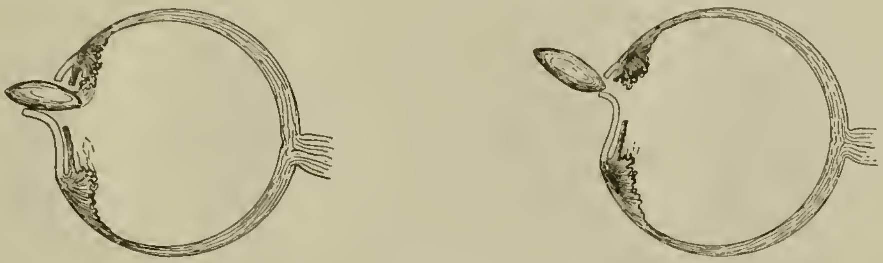


Smith-Indian Cataract Extraction.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. Point (a) where the tip of the delivery hook is to be applied to make traction on the zonula in the direction of the patient's feet. This frees the lens below. It is still anchored above and the intraocular pressure causes it to swing outwards and turn over.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. Advanced stage of the same manipulation. Note the wide, gaping wound, somewhat exaggerated in the cut.

The bulbous point was too large to get well down into the angle, so that there were cases of incarceration of iris and dislocation of the pupil which should not have occurred. I am satisfied that better results will follow the use of my smaller iris hook and repositor previously described and pictured. By the use of this instrument the iris may be smoothed out of the angles and from the under surface of the posterior lip of the section by gently passing the flat end of the repositor, which has been bent to an obtuse angle, between the iris and the under surface of the posterior lip of the section. By elevating the hand the same end will also free the angles; or, better still, the instrument may be reversed and the probe pointed end, which has been bent to a right angle, with the shank 2 mm. from its tip, employed for the same purpose.



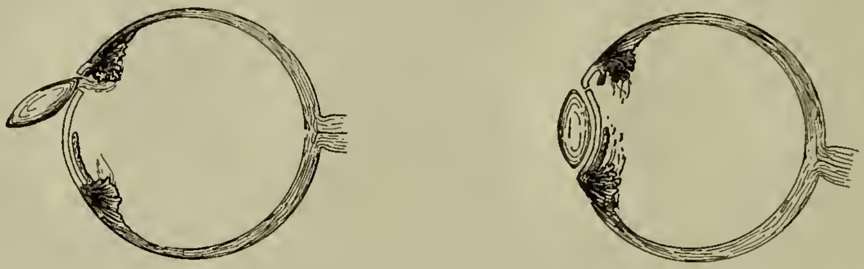
Smith-Indian Cataract Extraction.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. Lens passing out through the section still anchored above, the cornea being folded under it with the hook. from the direction of the pressure. The cataract fills the wound. Vitreous is seldom lost at this stage.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. The lens in an advanced stage of birth. It is now beyond the perpendicular meridian but is still held by a few zonular fibres. The cornea is folded farther under it.

I have lately modified this iris repositor by having the probe-pointed tip bent to an obtuse angle with the shank and made sharp, as referred to on a previous page. While a carefully made toilet is of great importance in any method of cataract operating, it is of especial importance in the intracapsular operation because the large size of the lens in its capsule is likely to crowd the iris up into the angles of the section in delivery, or even cause it to prolapse. In either event it is a source of irritation, may delay or even prevent healing of the section, or may furnish an entrance for pathological germs into the interior of the eye. The absence, also, of the posterior capsule and the crowding forward of the hyaloid by the normal intraocular pressure may further increase the difficulty of making a careful toilet. In my experience high blood pressure and high intracular tension in a cataract patient have more to do with interfering with the ease and completeness with which the iris can be replaced and smoothed out than all other causes combined. Hence the importance of reducing the blood pressure to as near 160 mm. as possible, while the intraocular tension should be restricted to normal limits (16 to 27 mm. Schiëtz), when that can be done.

The author's cataract-in-capsule toilet. The dressing should be made according to the taste of the operator. I prefer a half-round, dry, cotton patch between layers of gauze, laid on the closed lids of each eye. The irregularities are filled out with small pledgets of picked cotton which are held in place by pieces of adhesive straps I use a flannel bandage for the patients on whom most of my operations have been performed—old soldiers, many of them feeble in mind and body, bad subjects, as a rule, for any operation. Unless the patient complains of pain, or unless there is some other urgent reason for it, the eye should not be inspected for 10 full days after this dressing. I have not found it possible to delay the first inspection of the eye so long in private practice but have gradually departed from Smith's rule and now remove the dressing on the third or fourth day, but only to separate the lids enough to see whether or not the chamber is formed. There is something to be said in favor of each of these plans.



Smith-Indian Cataract Extraction.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. Lens free from all attachments and showing a tendency to fall away from the eye.

Turn-over Delivery of the Lens ("Tumbler") in the Unruptured Capsule. The lens is delivered, the lips of the section have come together and the cataract is lying in the concavity of the cornea.

Visual results. At the meeting of The American Academy of Ophthalmology and Oto-Laryngology in 1906, I presented a report on the "Visual Results Secured In 22 Intracapsular Extractions of Cataract by Smith's Method" as I pictured his technic from his article in the *Archives of Ophth.*, Vol. XXXIV, p. 601. The average vision of fifteen given glasses was practically 20/40. Vision would probably have been higher had the patients been more carefully tested, but the high average of sight after the operation was not appreciated at that time.

At the meeting of the A. M. A. in June, 1909, I presented a report on the visual results secured after 75 Smith intracapsular operations, in 69 of which the following vision was secured:—

2—20/15
30—20/20
18—20/30
4—20/40
9—20/50
5—20/70
Average vision 20/27.

At the meeting of the A. M. A. in June, 1912, Millette and the writer presented a paper on the visual results in 203 patients after the Smith-Indian operation. We had visual records of 182 with the following showing:

4—20/10
36—20/15
61—20/20
35—20/30
12—20/40
14—20/50
13—20/80
4—20/100
3—20/200
Average vision 20/23

Summary. Finally, my matured belief is that extraction of cataract within the capsule offers the following advantages: 1. A cataract can be removed at any stage of development. 2. No discission is ever necessary. 3. There is comparative freedom from post-operative inflammation. 4. There can be no capsular entanglements in the wound; prompt healing is the rule. 5. The method is especially adapted to institutional work; one operation does all. 6. No ripening methods need be tried. 7. The result is better average vision, which is the end and aim of every cataract operation, and the vision once secured does not deteriorate with time, if the fundus remains healthy.

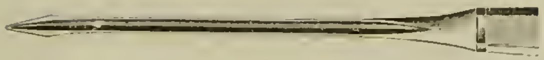
The disadvantages of the method, as I have met them, are the following: 1. The operation is highly technical, and can only be learned at the elbow of an expert, who has plenty of material to demonstrate it. This material is now only available in Smith's clinic at Amritsar. 2. Loss of vitreous is the only serious disadvantage, which, it must be admitted, is slightly greater for the average operator than after the regular method. 3. Traumatism as a rule (to which there are many exceptions) is greater than in the regular operation. 4. From a cosmetic point of view, a wide, updrawn pupil (if it results) mars the appearance of the eye, while it may not cause any diminution of vision. 5. A skilled assistant is always necessary in performing this operation. 6. The extremes of age do not furnish varieties of cataracts as suitable for the method as does the middle period of life. 7. In America greater quietude of the patient and slightly more prolonged convalescence than in India is the rule to which, however, there are many exceptions.

I do not desire to be considered a champion of the Smith-Indian, or any other, cataract operation. There is a broader ground on which to stand, viz.: That operation should be selected which seems best suited to the case in hand, *rather than to select the case for the operation.* Certain types of cataract, I am sure, will show fewer complications and better average visual results when extracted in the capsule than if operated by regular methods, and the converse must be true. But having emphasized the strong point of intracapsule extraction, especially of the Smith-Indian method, and having admitted its weak points as I have observed them in about 850 operations, I cannot avoid the conclusion that the Smith-Indian procedure well deserves a place among cataract operations, and that its technic is a long step towards the ideal operation, which has been the dream of operators from the beginning.—(D. W. G.)

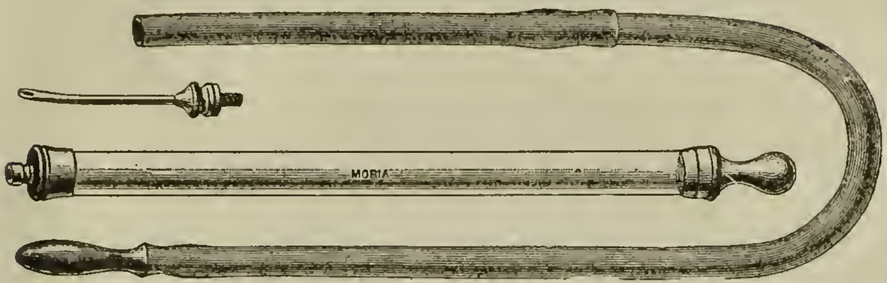
Cataract, Iridectomy in operating for. See **Cataract, Senile.**

Cataract, Juvenile. Soft cataract. This form of the disease is said to constitute from one-third to one-half of the cases of congenital cataract (q. v.). Speaking generally, if striæ of an irregular, mottled appearance are noticeable by focal illumination, or otherwise, one has to deal with a *soft* cataract only. In some instances, however, the mass of the cataract is of a uniform white color throughout, and close inspection indicates movement within it; in which case we have to deal with a *liquid* cataract.

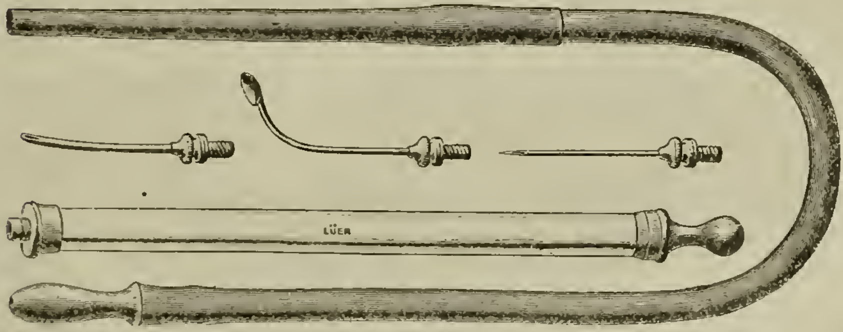
Treatment. As a rule, the consistency of a cataractous lens closely corresponds to the age of the patient. Until six years of age all forms of infantile and congenital cataract show an absence of distinguishable nucleus. Panas, Turck and Henry Smith have reported a few exceptional cases in which a nucleus, more or less resistant of the ordinary discission operation, was present, but such rare instances may be ignored in the conduct of juvenile cataract. *Discission* (q. v.) in any of its simple forms is the safest—if the most lengthy—procedure for the treatment of all states of juvenile cataract before, say, the age of ten. There is an especial reason for patiently awaiting the slow process of absorption following one or more simple discissions on the juvenile cataract, instead of resorting to some of the more rapid methods, like aspiration, expulsion of the masses through a corneal opening, etc., and that is the preservation of a central, movable pupil. Although a number of operators habitually perform and recommend more expeditious procedures, yet in the latter instances the danger of an irregular pupil and hernia of the iris (with other possible complications) do not



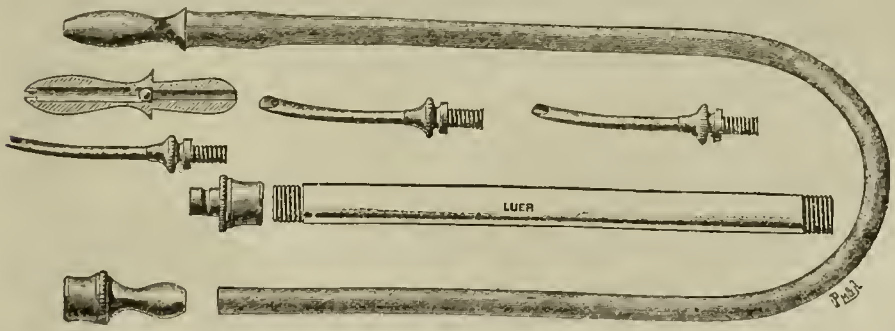
Walton's Grooved Needle for Soft Cataract.
The soft matter escapes from the anterior chamber by way of the channel in the needle without encouraging iris prolapse.



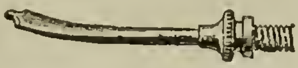
Redard's Simple Soft Cataract Aspirator.



Redard's Suction Apparatus for the Removal of Soft Cataract, showing also Aspirator Needle and Spoon.



Aspirator of de Lapersonne, for Removal by Suction of Soft Cataract. All the parts, including the rubber attachments, may be safely sterilized by boiling.



Sauvineau's Special Canula for the Aspirator, to be Employed in the Suction Operation for Soft Cataract.

seem to compensate the shorter period of waiting and the lessened professional care. Even if by the performance of an iridectomy the therapeutic care is diminished, still the patient goes through life with a mutilated iris and an abnormal pupil.

Various *suction devices* for the aspiration of soft cataract are described and pictured in this *Encyclopedia*. See, for instance **Bowman's syringe** in Vol. 2, p. 1265, for a discussion of the subject, as well as the various cuts under this heading.

Walker's lens-knife (see illustration) is so fashioned as to permit the escape of soft matter through the corneal opening made by it with a minimum danger of iris prolapse. The legends below other instruments sufficiently indicate the purpose and method of employment.

The element of time necessary to bring about discissional absorption of the lens may be ignored for infants and very young children in view of the lessened danger of the method.

When the patient is older, say from ten to thirty, discission alone or combined with suction or the removal of the discission masses through a corneal opening, may be done in cases where there is no reason to suspect a distinctly hard nucleus. If the nuclear elements be sclerotic the masses remaining after the expression of the softer parts will not be readily absorbed and will be likely to cause intraocular complications. It is a question whether it is not wise (mainly to prevent incarceration of the iris) to do a preparatory iridectomy in all cases of soft cataract above the age of ten when an opening is made in the cornea or sclero-cornea for the expulsion of cataractous masses, and particularly if one deals with a hard nucleus.

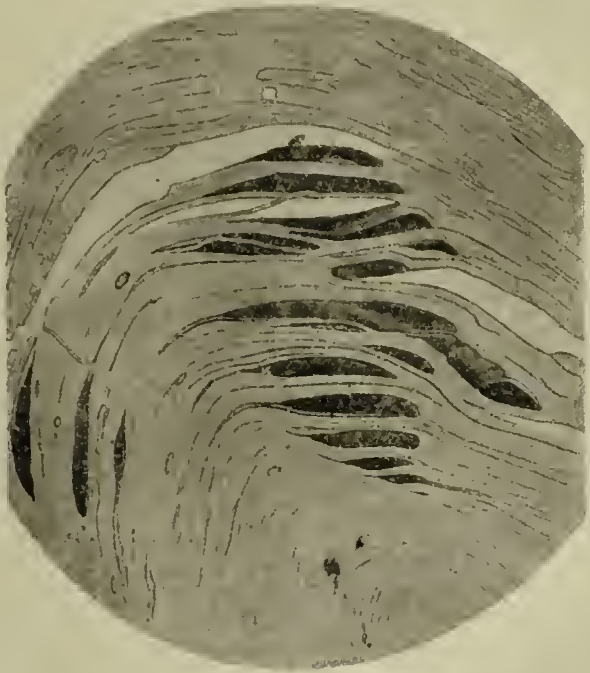
Still later, say after thirty years of age, any of the operations for the extraction of cataract may be done except that the sclero-corneal incision need not be made as wide as for the larger and harder cataract of advanced life.

Cataract knife. See **Cataract needle.**

Cataract knives. See **Cataract, Senile**; and **Instruments.**

Cataract, Lamellar. ZONULAR CATARACT. PERINUCLEAR CATARACT. LAMINAR CATARACT. This is one of the congenital forms of the disease which was first examined microscopically and described by Deutschmann. He found the nucleus of the lens and the cortex to be normal but they were separated by a zone of degenerated fibres, interspersed with many vacuoles and minute drops of myelin. Fissures between the fibres were also present, filled with granular débris.

It is not easy to account for the pathological changes in lamellar cataract. Horner believed that a layer of pathological lens fibres was, either before or immediately after birth, deposited around a normal nucleus. He also thought that this pathological condition was due to rickets or to some similar general condition. Other observers taught that alterations in the general nutrition affected the whole lens, which at the time of development represented the nucleus. Subsequent to this formation there was a general contraction of the affected part which caused the formation of vacuoles. According to Parsons (*loco cit.*, p. 402) other observers have confirmed these findings: "The contents of the vacuoles, which diminish in number from without inwards, generally stain with hæmatoxylin and benzoazurin (Heinzel); sometimes they do not stain, thus resembling the albuminous deposits in senile cataract. Ginsberg found them unstained by hæmatoxylin and Russell's stain, but colored pink with Weigert's resorcin-fuchsin stain; sometimes the walls of the spaces stain when the contents remain colorless. The large sickle-shaped clefts corresponding to the riders and their contents give the same staining reactions as the vacuoles." See, also, **Cataract, Zonular.**



Reiterchen, i. e., "Riders" or "Little Horsemen," Characteristic of Lamellar Cataract.

They are so-called because the degenerated crystalline fibres seem to ride upon the normal fibrillæ. (Hess.)

An abstract (*Oph. Review*, Jan., 1908) of Ruhwandl's paper (*Zeitschr. für Augenheilk.*, Nos. 5 and 6, Vol. xvii) discusses this subject. The latter publication is based on the examination of the lenses for six subjects, aged from 8 to 54. The diameter of the nucleus was found to vary between 2½ and 3½ mm., considerably smaller than the diameter of the lens at birth. In all but two cases the nucleus was found to contain spots similar to those described by previous observers and generally thought to be holes. In two, however, no such spots could be seen. The perinuclear zone, where the greatest amount of opacity usually occurs, varied in thickness in these cases between 4μ and 0.1 mm., and the microscopic appearances did not, in the opinion of the author, tend to confirm the theory widely held that this zone is due to shrinking of the nucleus. The cortical zone showed very varying appearances, being in some cases normal, in others showing "outriders" continuous with opacities in the intermediate zone and the nucleus.

Two theories of the causation of lamellar cataract are still held, one that it is due to a developmental defect, the other that it is the result of defective nutrition during the first few years of life. The main difficulty about the latter theory is that the diameter of the lens at birth is considerably greater than that of the perinuclear zone in which the bulk of the opacities in lamellar cataract are usually found. Hence, if the opacities are due to any post-natal cause it must be one that can injure not only fibres in course of formation, but fibres which are already formed, or else such a cause as would involve a great shrinking of the lens nucleus. Ruhwandl, as has been mentioned, is inclined to reject the theory of shrinking as untenable and to fall back on the first theory, that the defect is developmental. In support of it he instances the fact that in a number of cases lamellar cataract is hereditary, and in a number of others is associated with other defects which are without doubt developmental. Moreover, there are a number of persons with normal sight in whom vacuoles in the lens exist, which vacuoles only differ in degree, not in kind, he maintains, from those existing in lamellar cataract. The argument that lamellar cataract is not usually discovered until after in the stage of infancy is no proof at all that it did not exist at birth: considerable defects in sight are often not noticed before school age. Moreover, it is not uncommon for the opacity of a lamellar cataract to increase while under observation. On the other hand—and this is a side of the subject to which Ruhwandl does not refer—the association of the condition with defects in the enamel of the permanent teeth seems to tell in favour of lamellar cataract having a post-natal origin (cf. Norman Bennett's paper in 1900, and Treacher Collins's remarks thereon (*Ophthal. Review,* Vol. xix, p. 357). Is it not possible that some cases may have an intra-uterine and others a post-natal origin?

Cataract, Laminar. Lamellar cataract (q. v.)

Cataract, Lenticular. Opacities in the lens entirely confined to the lens mass, without implication of the capsules.

Cataract, Lightning. Blitzstaar. The production experimentally of cataract by discharges from a Leyden jar was reported years ago by Hess (*Bericht der VII. Internat. Ophth. Kongress,* Heidelberg, 1888). Since then Silex, Leber, Vossius and others have reported undoubted examples of lenticular opacities, more or less marked and generally progressive, resulting from a stroke of lightning. This subject is further treated under **Cataract, Electric.**

Heinrich Freysz (*Beiträge zur Augenheilk.,* Pt. 4, Dec., 1909), attempts to reach some conclusions regarding the pathogenesis and development of electrical cataract by reviewing the experimental results of others and concludes that electricity, light and mechanical action are the factors which different observers have invoked to account for the development of cataract in persons exposed to the effects of lightning and other powerful electric discharges.

He believes it is necessary, for the production of electrical cataract, that the current should pass through the body of the injured person. The lens opacities are the result of an electrolytic change, i. e., they are produced by the electric current itself, and not by the light or by mechanical shock. The opacities make their first appearance in from one to four months after the accident, and usually progress rapidly to maturity. The results of operative treatment are good.

Cataract, Maturation of. See **Artificial ripening of immature cataract.**

Cataract, Membranous. In an adherent cataract (q. v.) if no erosion of the capsule takes place a gradual decrease in volume of the affected lens generally sets in, and the cataract is eventually represented by a membrane composed of the remains of lens fibres, myelin globules, chalk concretions and indefinable detritus—all lying between the leaves of the capsule, which have become thickened owing to proliferation of the epithelium. See, also, **Cataract, Siliquose.**

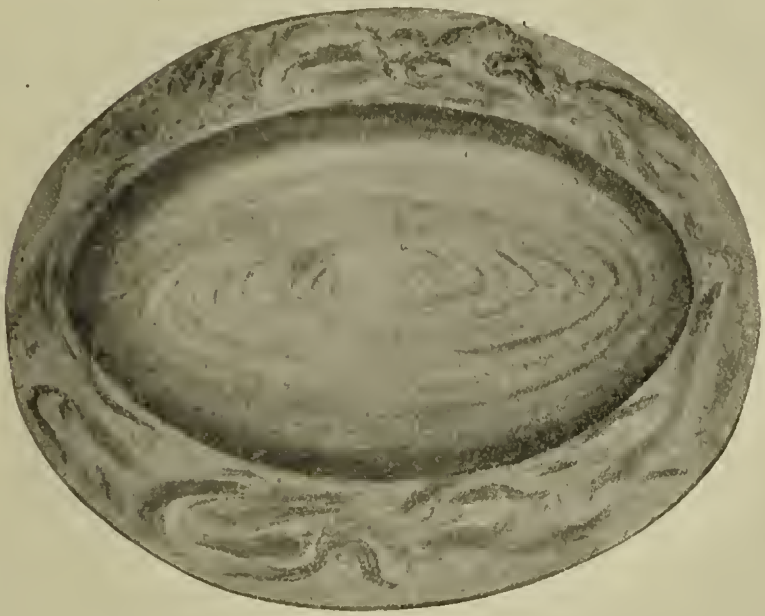
Cataract, Mendelian. The iridic coloration, as well as several forms of familial cataract have been shown (together with many other structural peculiarities) to follow Mendelian lines. This subject is too complex to consider here, but it may be said that the zoological and botanical work of Gregor Mendel (1822-1865) on heredity and the laws that govern it, in its human relations particularly, have been studied and elucidated by W. Bateson (*Brain,* Part 1141, 1906; and *Mendel's Principles of Heredity,* 1909) and others, and have been recently popularized. Mendel showed that not only are the diseases of man but his other physical qualities—including his intellect—"dependent upon the ascertainable presence or absence of definite 'unit-characters' whose mode of transmission follows fixed laws.''

Cataract, Menthol. This is one of the numerous, so-called toxic cataracts produced by experimentation on the lower animals. It has long been known that either common salt or sodium nitrate, introduced in large quantities into the large intestine or under the skin of frogs, dogs, kittens, etc., produce lenticular opacities. The same thing is true of strong solutions of sugar. It is a moot question whether these changes are due to the extraction of watery elements of the lens or to an introduction of chemical substances beneath the capsule.

Cataract, Monostomum lentis (von Nordmann). According to Norris and Oliver this parasite, one of the Trematodes, has been seen in the acquired cataract of a woman. The case described by Przibilsky is as follows: At the upper margin of a detached retina in the region of the macula a rod-like projection was seen, which after two months had passed completely into the vitreous, while the detachment of the retina had disappeared. This object showed varying independent movements. Its lower end was bent sharply backward and flattened. Later two new processes developed from it. No operation was done.

Cataract, Morgagnian. The name commonly given to an over-ripe, much degenerated cataract in which the cortex is partially or wholly liquefied, leaving a hard nucleus loose in a bag of opaque, generally milky fluid. Morgagni, after whom this form of cataract is named, was not aware of its true character. He believed that a normal ''humor'' exists between the capsule and the lens and when the secretion of this humor is (pathologically) interrupted the crystalline became ''dry'' and opaque. Hence, *cataracta arida*, or ''dry cataract,'' one of the supposed forms of the disease. Burton Chance (*Journ. Am. Med. Assoc'n.*, Nov. 24, 1912) remarks that this form of cataract is not of very common occurrence among the younger generation of surgeons. Since 1890, no case had been presented to the Ophthalmic Section of the American Medical Association, and there was no report of any in the *Transactions of the American Ophthalmological Society*. He further says that Taylor, ''in reporting a case before the Ophthalmological Society of the United Kingdom, remarks that for thirty years past not a single instance had been brought before that society. Pathologically, they cannot be rare; it may be that now they are not common, clinically. Perhaps it is that we are consulted earlier than the older men were, so that the cataracts we see are firmer; or more probably, we are not consulted at all by those in whom extreme hypermaturity is present. However this may be, references to them in the past ten years are few in number.

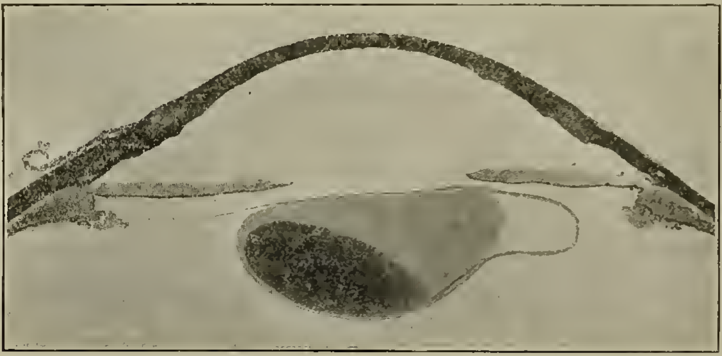
Morgagnian cataracts are usually monocular and, as is most evident, occur in long-standing cases, that is, one eye becomes cataractous in middle age and the patient becomes reconciled to the inconvenience attending it and does not seek advice until the onset of cataractous symptoms in the other eye. Such cataracts sometimes follow serous cyclitis and in some of the cases more or less extensive degenerative changes have taken place in the choroido-retinal tunics, though this, of course, cannot be seen until after the extraction of the opaque lens. Other cases have been those of congenital total cataracts. Cataracts, even at birth, may be so disintegrated as to present softening of the cortex with the harder center which has sunk to the bottom of the capsule; or they may be completely fluid with the absorption of the imperfect nucleus. Such cases can hardly be considered as having ever been mature; on the contrary, they have been caused by a failure in the development of the lens, the fibers of which have been replaced by an opaque albuminous fluid. Yet clinically, as Treacher Collins (Developmental Deformities of the Crystalline Lens. *Jour. A. M. A.*, Sept. 26, 1908, p. 1051) pointed out in 1908, they are entirely comparable to the Morgagnian cataracts of adult life.



Early Stage of Morgagnian Cataract.

In the centre is the still unchanged nucleus. The cortex is disorganized, of fluid consistency and exhibits round Morgagnian bodies. (After Greeff.)

In Morgagnian cataracts in old lenses the cortex liquefies, becomes milky-white in appearance and the substance homogeneous. In the lower portion there is present a semicircular, dark, or brownish shadow cast by the upper half of the dense nucleus which has sunk to the bottom of the lenticular sac. The brownish shadow can be seen to change its position as the position of the nucleus is altered by the movements of the head, and when the pupil is dilated, the difference in the color of the reflex may readily be noted—it is yellowish when the patient is standing up and milky-white when he is lying down. It is not always possible to distinguish the nucleus, because its outlines may be hidden by the opaque cortical, which, as is well known, can be denser and more impervious to light than a hardened lens.



Morgagnian Cataract. (Elschnig.)

It may be of interest to consider the genesis of the Morgagnian cataract. It comprises the metamorphosis of a mature cataract into a state of liquefaction, and it is probable that the changes are truly inflammatory in type. The epithelium proliferates and we have a thickening of the capsule which retains the water of disintegration in which the cortical mass is dissolved, or, the cortical lens substance is gradually absorbed and is partially replaced by fluid to such an extent that the nucleus moves about in it and gravitates to the lowest point within the capsular sac. The fluid cortical substance may remain yellowish or become entirely opaque, whitish or murky. The nucleus remains unaltered or shows only an eroded surface due to a slight absorption of its substance, and it may contain Morgagnian droplets and cholesterin crystals, as in Claiborne's case (*Arch. Ophth.*, 1909, p. 513). The capsule may rupture and allow the nucleus to escape through the rent into the anterior chamber, as happened in Ewing's case (*Am. Jour. Ophth.*, 1909, p. 328).

There are many ways in which the obstruction due to cataract may be removed. If the patient lives long enough, the lens may so far liquefy and become absorbed as to leave only a small remnant within the capsule, or the capsule itself may be absorbed. Sometimes the lens may be dislocated and without harm sink into the vitreous humor, thus effecting the restoration of sight to ardent devotees on pilgrimage to famous curative shrines. In Chance's notes of unusual cases observed while resident at the Wills Hospital in 1894, he found one relating to the extraction of a hypermature cataract, as follows:

"Surgeon R., when about to lay down his knife at the completion of the incision, was startled to see the lens ejected from the eye through the wound and light on the pillow some distance from the patient's head. The lens resembled a large white pearl, but after a few oscillations the capsule ruptured and a milky fluid ran out leaving a dense nucleus within the folds of the capsule. This extraordinary occurrence was followed by an uneventful recovery."

Sometimes the fluid is completely transparent and the nucleus may fall below the pupil sufficiently to allow the vision to be corrected by an appropriate lens, as in a case reported by von Reuss. In others, the capsule has remained more or less transparent, so that the sight has even improved. In a case reported by Calderaro, the absorptive processes must have progressed far, for the fluid surrounding the nucleus was entirely transparent, and, on microscopic examination, the lining cells of the capsule were completely lacking.

In the treatment of Morgagnian cataracts we must try to extract them within the capsule. Certainly an iridectomy must be performed, and, in selected cases in which deliberation may be needful, a preliminary iridectomy will yield even better results. Lens spoons or wire loops of dimensions sufficient to engage the nucleus within their span should be used. These should be introduced well behind the lens, though held somewhat vertically, with the surgeon's mind, so to speak, occupied solely on the loop with the thought that it must be transported through an arc about the short axis of the instrument. With it the lens is pushed up against the cornea; then with a scoop pressed against the external surface the lens is made to glide well on to the loop, and it is then easily withdrawn, counter-pressure being made externally with the scoop until the lens is removed. A skilled assistant is required in this operation to manipulate the external instrument while the operator steadies the globe with the fixation forceps in one hand and the loop or spoon in the other.

It is important to observe the behavior of the escaping cortical fluid—a granular milky fluid, like fine starch grains—as it may swell through the action of the aqueous humor and if it should not all be dissipated by the time of the closure of the wound, it may excite ciliary inflammation and cause an increase of tension.

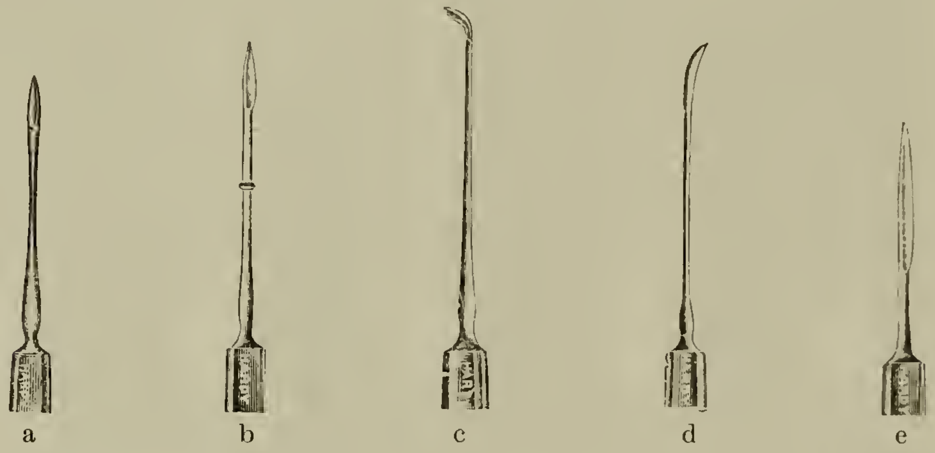
In the treatment of congenital fluid cataracts of the Morgagnian type, if there be a pouring out of the milky fluid into the anterior chamber, the aqueous should be completely evacuated at once to prevent the swelling and increase of tension, just as in senile cases.

Chance believes that it is not wise to allow hypermaturity to extend as far as liquefaction. In the very commencement where a cataract becomes whitish or milky, we have ground to suspect that the exterior layers are fluid or semifluid. The weakness of the zonula favors rupture of the hyaloid with the consequent escape of vitreous. It is by no means easy to engage a floating nucleus, and traumatism occasioned by one's efforts to extract the nucleus may hinder the healing of the enfeebled globe. It is therefore best to encourage operation in the period of maturity and even earlier. The risks at this stage are less, all things being equal, than later. It is more than likely that the consistency of the vitreous may have become so disturbed when a cataract is overripe that the escape of it then will prove of greater moment than when even a large bead presents during the extraction of a hard cataract. Neither must the possibility of the rupture of the capsule with the dislocation of the nucleus into the anterior chamber or on to the ciliary body. as happened in one of his cases, be overlooked.

Cataract, Naphthalin. It has been known since 1887 when Bouchard (*Recueil d'Ophtalmologie,* 1887, p. 91) first called attention to it that the ingestion of naphthalin produces cataract. Practically all that we know about this toxic condition is the result of animal experiments. The opacities in the crystalline are in this case, as in that of beta-naphthol, secondary to interference with the nutrition of the lens, probably to disorders of the intra-ocular circulation, especially in the choroid. As shown by Ovio and Mania lenses immersed in olive oil or naphthalin do not become opaque. Norris and Oliver (Vol. 4, p. 293) give the following abstract of the early experimental research made on this subject. Kolinsky found that "it acted on all inward parts, the smaller the animal the greater the effect of any given quantity of the drug. The cataract appears always to be a secondary one and dependent upon changes in the ciliary body, the vitreous, the retina, and the choroid. The first lesions observed are hemorrhages into the ciliary body and into the choroid. These are accompanied by edema of the retina and lens, and later by separation of the vitreous and of the retina. When large doses are administered the lens swells quickly, and fluid is found between the capsule and the lens-fibres, with degeneration of the cortical fibres. Naphthalin cataract, when once started, may go on to become more dense without any further administration of the drug. Once fairly developed, it never entirely clears up, but always leaves some opacity behind. In the latter stages crystals of phosphate of lime are deposited in the lens. There is edema of the retina and lens, with marked proliferation of capsular epithelium and the formation of giant cells. Magnus found that when he gave rabbits three to four grammes of naphthalin for each kilogram of weight, the first appearance of cataract could be sometimes seen after six hours. These appearances consisted of transparent stripes in the lens, corresponding to deeper grooves in the lens substance. A little later peripheral cloudiness sets in in the anterior and posterior cortical. There was marked proliferation of epithelium, and there was fissures between the fibres filled with cloudy fluid. According to Magnus, the lenticular opacity thus produced may disappear in eighteen days. The same author found that the use of ten to twenty grammes of common salt produced clouding behind the equator in four hours, while in a dog or in a cat one hundred grammes of grape sugar produced cataract, the opacities showing themselves at the equator. Hess agrees in the main with the foregoing statement, and describes the first signs of naphthalin cataract as fine, clear shoots in the equatorial parts of the lens, which soon become cloudy and coalesce with neighboring stripes, so that in ten days the entire sub-capsular cortical may become evenly cloudy." Magnus, Kolinsky, and Hess all agree that in the early stage of naphthalin cataract there is great congestion of the ciliary body and processes, and it is possible that by the altered secretions of these parts the pabulum of the lens becomes abnormal and its nutrition impaired. Klingmann, also, insists that there are always symptoms of iridocyclitis before the slightest clouding of the lens takes place. It should be also stated that naphthalin usually produces a violent catarrhal diarrhea in the animal to which it is administered.

Cataract needle. Among the instruments useful in performing the operation of discission the models of Knapp, Hays and Ziegler are each excellent. G. B. Jobson, Jr., and H. P. Hammond have invented an iridotomy knife (*The Ophthalmic Record,* Sept. 1908, p. 448) which is similar to a cystotome with a large blade set at an angle to the shaft. The blade is made very thin, and broad and sharp-pointed, and is as long as the distance from the posterior surface of the cornea to the iris will permit. A. J. Erwin suggests a knife for secondary cataract that is about the size of the smallest discission needle, curved about 50 degrees on both the edge and the flat, with both edges and point sharp. Its action is corkscrew-like; by a rotary motion one may tear the capsule or draw it to the corneal margin and extract it.

(*Trans. Section of Oph. A. M. A.*, 1896, p. 112.) A. G. Heyl's discission needle is bent at an angle of 15°; it is 11 mm. long and 5 mm. broad. (*Am. Jour. Med. Sciences,* Aug. 6, 1885.) C. Pascheff (*Ophthalmic Review,* March, 1905, p. 70) describes his iridotome which consists of two lancets gliding one within the other. One terminates with a kind of cutting hook, which is intended to go below the iris; the second ends with a blade destined to cut through the part of the iris included between the two. M. H. Post (Knife for Dividing Obstructing Pupil Membranes, *Amer. Jour. of Oph.,* May, 1908, p. 129) describes an instrument, whose blade, 6 mm. long and 1¼ mm. wide at its widest part, about 3 mm. from the point, has its back straight and dull, and a sharply-rounded cutting edge extending its entire length. The shank is cylindrical and of a diameter sufficient to prevent the escape of aqueous during operation. John E. Weeks has invented a discission knife, a curved knife-needle, shaped something like a sickle. A hooked extremity is formed by a curve which extends from the middle of the blade to the point. The blade is about ⅔ mm. in width, and the shaft is just large enough to fill the opening made by the blade when the knife is properly entered. The concave edge and the point of the blade are rendered as sharp as possible; the convex edge of the point, for one millimeter up, is also sharpened. (*Trans. Am. Oph. Soc.*, 1895, p. 398.) F. Buller's double needle to facilitate discission operation consists of two needles, 0.25 mm. in diameter and very sharp, placed exactly parallel in one handle. Their object is to transfix and steady the dense capsule while the discission is performed with the knife needle. (*Trans. Amer. Oph. Soc.*, 1899, p. 563.) See, also, **After-cataract, Operations for.**



Knife-Needles. a, Pagenstecher's; b, Sichel's; c, Jobson's iridotomy; d, Knapp's (with stop); e, Knapp's.

Cataract, Nephritic. The attention of the profession has been directed by Frankel and Deutschmann in particular to diseases of the kidney and albuminuria as a source of cataract. The latter observer found albumen in one-third of his cataract cases. Becker (*Die Universitäts-Augenklinik in Heidelberg*, 1888, p. 58) estimated that 6 per cent. of his cataract patients had albumen in their urine. The exact relation of various forms of kidney diseases and albuminuric conditions to lenticular changes had not been definitely settled; probably it is an indirect connection in most cases. There is nothing distinctive about nephritic cataract.

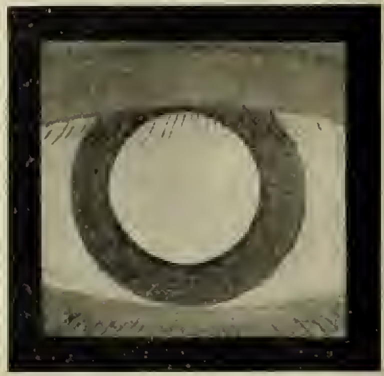
Cataract, Nettleship's. A synonym of *discoid* or *Coppock cataract.* Under the latter heading this congenital, familial and rare form of stationary cataract is pictured and described. See, also, **Congenital anomalies.**

Cataract, Nitrate of sodium. This is one of the numerous, so-called "toxic" cataracts produced by experimentation on the lower animals. It has long been known that either common salt or sodium nitrate, injected in large quantities into the large intestine or under the skin of frogs, dogs, kittens, etc., produces lenticular opacities. The same thing is true of strong solutions of sugar. It is a moot question whether these changes are due to the extraction of watery elements of the lens or to an introduction of chemical substances beneath the capsule.

Cataract, Nuclear. In this opacity of the lens the nucleus is involved exactly as it is in *lamellar cataract* (q. v.), except that the interfibrillar spaces, or vacuoles, are more numerous.

As a variety of senile or presinile cataract it is not very common. It is characterized by the fact that the nucleus becomes uniformly cloudy while the cortex remains more or less completely transparent. (See **Cataract, Unripe.**) The central opacity is less marked at its periphery, and the opacification finally loses itself in the normal lens-substance without a sharply-defined border. This variety of senile cataract appears not uncommonly between forty and fifty years of age, and is found mostly in high degrees of myopia. By oblique illumination a well-marked, gray reflex is seen. By means of the ophthalmoscope also the central opacity is generally easily defined. In its later stages this species of cataract may be transformed into the so-called *black* or *brown* form *(cataracta nigra vel brunescens)* (q. v.). The operative prognosis while not, perhaps, as good as in some other forms is nevertheless not bad. As the lens-mass itself is generally greater than in uniformly mature cataracts, where sclerotic processes are advanced, the sclerocorneal section should be made more extensive than in ordinary cases.

Treatment. In cases of nuclear cataract either of the juvenile, non-progressive type, or in true senile cataract of slow development, in which for any reason a preliminary iridectomy cannot be done, Neves Da Rocha, (*Anales de Oftalmologia,* February, 1913) dilates the pupil for optical purposes with euphthalmin, in three to five per cent. solution or salve, and has never experienced any inconvenience from its use. The intraocular tension and accommodation are not affected, and no toxic effects are produced. Pupillary dilatation, after use of the three per cent. solution, begins twenty minutes after instillation and lasts about four hours; about six hours after the five per cent. mixture. Yellow glasses are ordered to avoid dazzling. This observer considers the remote danger of increased tension during the night; hence he advises that the drug should not be used after six o'clock in the evening.



Nuclear Cataract. (After Axenfeld.)

The operative treatment of nuclear cataract is essentially that of most other immature varieties. When the reduction of vision is due to an *advancing* opacification a preliminary capsolotomy or intracapsular extraction is indicated. In the former event washing out the soft debris with the anterior chamber syringe may avoid a troublesome after-cataract.

Cataractocatapiesis. (L.) The operation of depressing a cataract.

Cataractocatathesis. (L) An obsolete term for couching or depression of cataract.

Cataract of adolescence. This term includes several varieties of soft cataract. Norris describes it as resembling skimmed-milk in color. It usually differs anatomically "from the cataracts of adult life in the fact that the entire lens, including the central portions, undergoes active cataractous degeneration and often becomes entirely fluid. At times it may be infiltrated with lime salts and may become solid throughout. Chalky degeneration is also found in fluid cataracts, which may have considerable quantities of granular cretaceous matter.

This tendency to infiltration with lime salts is much greater in the cataracts of youth than in those of old age. The soft cataracts of adolescence go on to shrink, and finally we find a small sac with much thickened walls, just as has been described in the degenerations of congenital cataracts. A certain grade of such shrinking and thickening of the capsule, owing to a fancied resemblance to pod fruits such as peas and beans, has been termed by Adam Schmidt *cataracta arida-siliquata* (q. v.)—a name which figures in most treatises to the present day. Where cataract develops in adolescents we should always look out for diabetes, for according to most authors the cataract which develops in such subjects presents no clinical characteristics to distinguish it from other varieties of adolescent cataract.''

Cataract of extreme old age. The characteristics—anatomical and other—of cataract occurring in extreme old age are practically the same as those in ordinary senile cataract. As a rule, the nucleus is larger, the cortex is thinner, and, as a consequence, the whole cataract is harder. Reports of extraction of cataract in patients between 80 and 95 years of age have been published. Considering the condition, both local and general, of such patients it may be said that mere age is no insuperable bar to success. Hasket Derby (*Boston Med. and Surg. Journ.*, 1895, Vol. CXXXIII, No. 13, p. 319) has reported 34 cases of extraction in individuals between 80 and 90 years of age. Of these 29 were successes, 2 were partial successes, 2 were failures, and one result was not recorded. See **Cataract, Senile.**

Cataract operations, Astigmatism following. There is always more or less interference with the corneal curve after cataract extraction, due chiefly to the repair of the corneal or sclero-corneal incision. As a rule, the cicatrization line causes a flattening in the meridian at right angles to it, so that the astigmatism has the meridian of least curvature at right angles to the line of incision. Jackson (*Ophthal. Review*, Dec., 1893, p. 349) made a study of astigmatism after cataract extraction. He believes that simple inspection and the use of Placido's disk will show that the corneal curve is normal after the operation, until the anterior chamber is re-established. In the course of the next two or three days, ''the corneal asymmetry becomes evident and quickly reaches its maximum. From this time onward the tendency is for the astigmatism to diminish, until at length a permanent condition is reached.'' The same author tells us that in sixty per cent. of the cases the change continued between two and three months; that in twenty per cent. change continued in the third month; but that in fifteen permanence was reached in the second month. The exact amount of astigmatism, as measured by the ophthalmometer, was found by

Dolganoff to be about 5 D. two weeks after the operation. This decreased to 2.8 D. three to four weeks after extraction, and to an average of 2.6 D. five to six weeks after. Numerous operations have been suggested to remedy this astigmatic defect, but none of them seems to be practical. For example, Lucciola was able to reduce the astigmatism, by a corneal incision, about 1 D.

Cataract operations, Colored vision after. A condition has been quite frequently observed in patients from whom a cataract of some months' standing has been removed, in which there appears a glaring white haze over all objects. Colors are almost abolished or are seen only dimly, and not in their true values. Arlt mentions this ''on first going out, which is usually in the evening, the patient observes that all objects appear as if covered with snow.'' In some cases this whitish look has persisted for a week, or even longer in two instances.

Instances of red-vision (erythropsia) are of frequent occurrence after cataract extraction. This phenomenon is also met with in the normal eye under certain conditions of exposure to a very intense light for a considerable time, as observed in those traveling through the Alps in winter, and in the Arctic regions. This appearance has been interpreted by others as a phenomenon due to retinal fatigue, believing that the eye having long been saturated by the yellow light coming through the nucleus of the lens, sees the complementary color after its removal. See, also, **Blue vision**; and **Cataract, Senile.** Blue-vision (*cyanopsia; also kyanopsia*) is not infrequently observed after cataract removal, and this condition has in some instances persisted for several months. Becker refers to this phenomenon in the Graefe-Saemisch *Handbuch* as follows: ''Immediately after the expulsion of the lens, the patient frequently sees everything, as the fingers held before him, not in their natural colors, but blue. This has been attributed to the operation of contrast, since the color perception of such patients must be affected by the intensely yellow color of the nucleus. If this were true the phenomenon should disappear a short time after the expulsion of the lens, and should not be present in the case of white cataracts which do not have a yellow nucleus. Neither is the case, however, and it can be more readily explained by the corticalis and thin layer of blood remaining in the anterior chamber. The blue-vision vanishes as soon as the remains of the corticalis are removed.''

Cataract operations, Hemorrhage following. See **Cataract, Senile.**

Cataract operations, Panophthalmitis following. See **Cataract, Senile.**

Cataract operations, Preliminary iridectomy in. See **Cataract, Senile.**

Cataract operations, Results of. See **Cataract operations, Statistics of.**

Cataract operations, Statistics of. These are numerous and sometimes of doubtful value. Especially is it difficult to compare the published accounts of different surgeons, since their operative methods, mode of determining post-operative visual acuity, etc., are so different. An average report is that of Schöler (*Archiv. f. Augenheilk,* p. 198, 1908, Berlin), in whose clinic from 1896 to 1907, 5,057 eye operations were performed. Of these 1,322 were for cataract, viz., 798 senile, 19 diabetic, 93 traumatic, 48 complicated, 42 soft congenital, 123 zonular, 199 secondary. Flap extraction upward, as a rule *with* iridectomy; 75 without. Simple extraction was considered indicated in relatively young persons, of whom quiet behavior after the operation may be expected, to give them the greatest possible amount of vision. Sublimate was used as antiseptic, and cocain, 5 per cent., as anesthetic in all cases of senile cataract. Prolapse of vitreous occurred in 38. In such cases the speculum was removed after expulsion of the lens without maneuvers for reposition, the palpebral fissure dusted with xeroform, which with the tears gives a very firm closure of the eye, and the single turn of the bandage sewed together. Weber's loop was used in 12 cases, in 4 of these the dislocated lens was extracted within the capsule. If possible, the patient remained in bed for 3 days. The other eye was not bandaged after the second day; the eye operated on after 2 weeks. Discissions for secondary cataract were made in 88 cases, i. e., in a proportion of 1 to 9, not earlier than three weeks after extraction, and always vertically to the lines of greatest tension, which must be carefully ascertained with the magnifying glass. There were 16 (2 per cent.) failures, 13 from purulent infection with panophthalmitis, 3 from iridocyclitis with subsequent phthisis. Seven patients died suddenly after the operation while still at the clinic. Preparatory iridectomy was performed in 29 cases, viz., 4 for artificial ripening, 7 for seclusion and occlusion of the pupil, 6 in anophthalmus of the other eye, 8 for glaucoma, 2 in purulent affections of the tear duct, 1 in diabetic retinitis, 1 in granulosis. The operation in 19 cases of diabetes was the same as usual, in 3 of them only fingers could be counted on account of diabetic retinitis.

In 13 out of 93 cases of traumatic cataract perfect vision was obtained; in 6 exenteration was performed, which is preferred to enucleation in infected injuries and panophthalmitis.

One hundred twenty-three cases of zonular cataract were operated upon, 50 bilateral, in 1 sitting. Only in 8 cases discissions, practically extractions, were performed. In most cases optic iridectomy is preferred, i. e., if by atropin vision is improved, as the preservation of accommodation is of paramount value to the patient, while the changing of near and distance glasses or bifocals is inconvenient. In almost all cases in which extraction had been performed on one eye, iridectomy on the other, the patients preferred the vision of the latter, even if the vision of the aphakic was equal or better. One may consider this as proof that iridectomy is the better method, and say that it cannot be recommended often enough to the blessing and contentedness of the patients. If, however, the opacities of the lens reach to the periphery and atropin does not improve the sight, discission or extraction is indicated.

Cataractopiesis. Couching or reclination of cataract.

Cataract, Osseous. The connective tissue growing into the exudate of adherent cataract (q. v.) from the ciliary body may invade the capsular sac and there suffer further changes and even lead to the formation of bone in the region of the lens.

It is not easy to explain the exact pathological process by which true bone is deposited in a non-vascular structure like the lens. Knapp and Virchow doubted its possibility, and yet instances—some twenty to date—of true ossification have been reported by Gluge—the first on record—by Alt, Goldzieher, Roure, Panas and others. Aubineau contributed a paper to the *Société française d'Ophtalmologie* in which the whole subject, à propos of a case in point, is fully discussed by him.

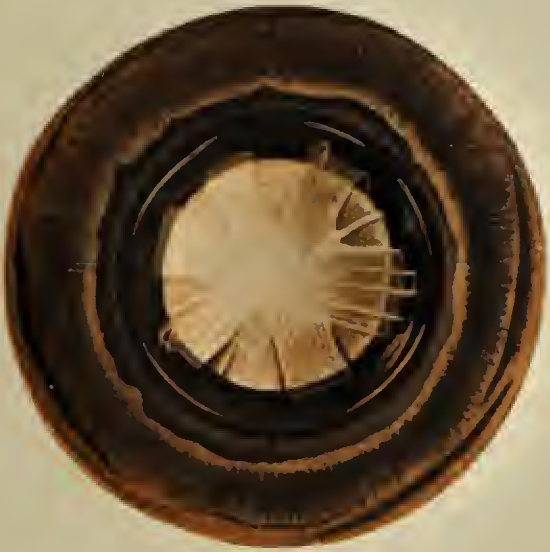
Cataract, Partial. Stationary cataract. Opacities that affect only a portion of the lens or its capsules appear as a transition stage in all progressive cataracts, but only those should be considered *partial* that remain *in statu quo* for years. These had better be called *stationary cataracts,* and under that name are elsewhere considered. With the exception of Thompsonian (senile) cataract, the Vossius ring cataract and a few others, partial cataract is usually axial and congenital.

Cataract, Perinuclear. This form of the disease is, according to Schirmer and Wintersteiner, a variety of zonular or lamellar cataract, in which the nucleus may be unaffected or only partially affected. It is surrounded by a degenerated zone. Outside of this again is a clear zone. This combination is usually associated with stellate, cortical or band-like opacities that run in layers towards, but do not reach, the periphery, which, in its turn, is not affected by the disease. This cataract is in its various forms and combinations stationary and mostly congenital.

Cataract, Phosphaturic. See **Cataract, Lamellar.**

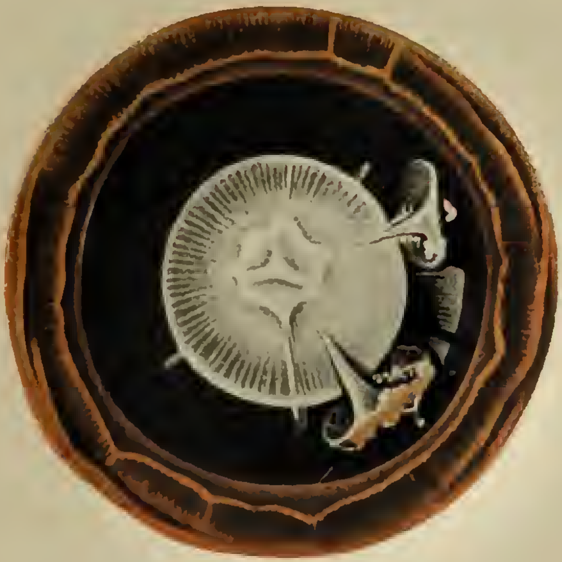
Cataract, Posterior capsular. See **Cataract, Posterior polar.**

Cataract, Posterior polar. Posterior cortical cataract. Postpolar cataract. An opacity at the posterior pole of the lens, which may be capsular, capsulo-lenticular (affecting both the posterior capsule



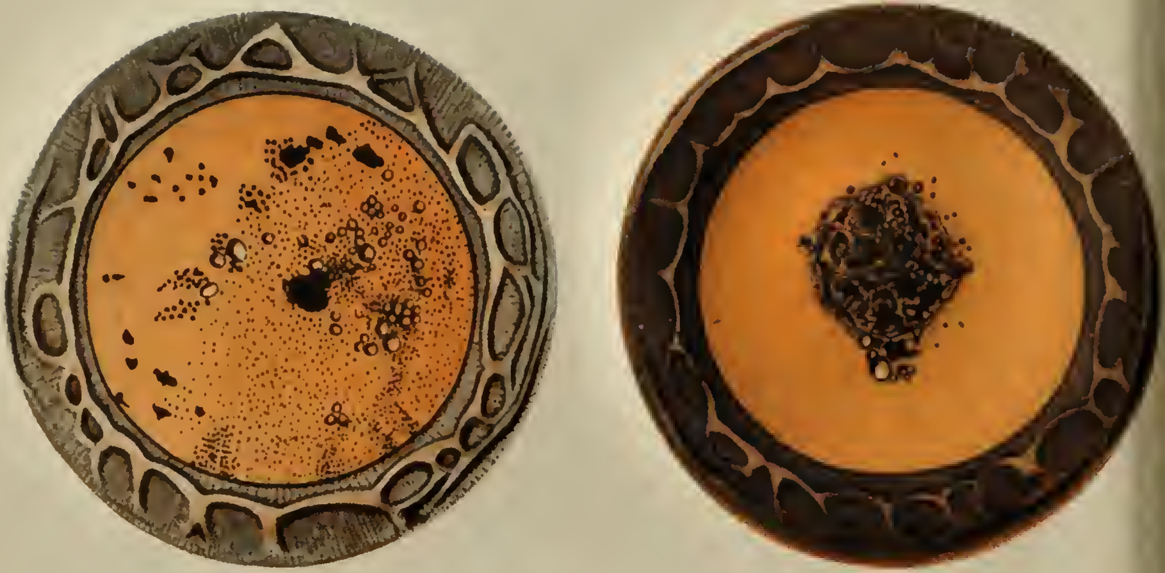
Cataract, Perinuclear.

Perinuclear cataract surrounded by band-like opacities. Focal illumination. (After Wintersteiner.)



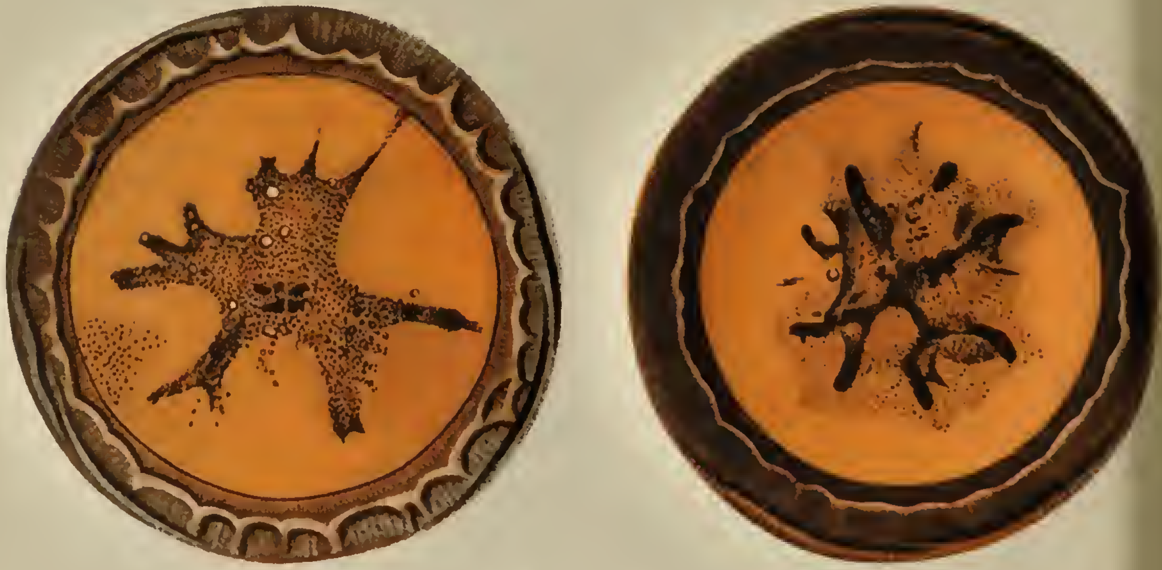
Cataract, Perinuclear.

Double perinuclear cataract. (After Wintersteiner.)



Posterior Polar Cataracts.

(a) Congenital posterior polar cortical cataract. (b) Posterior polar lenticulo-capsular cataract, following detachment of the retina. (After Wintersteiner.)



Posterior Polar or Retinitic Cataract.

(a) Post-polar stellate opacity from diffuse chorioretinitis. (b) The same variety due to retinitis pigmentosa. (After Wintersteiner.)

and the lens substance), or it may be entirely within the capsule. It may be either *congenital* or *acquired.* In the former case it is of the *capsular* type, and generally occurs as a remnant of the *membrana capsularis* of fœtal life. It is often associated with other congenital abnormalities, like persistent hyaloid artery or uveal coloboma.

Acquired posterior polar cataract is nearly always the result of fundus disease, especially of *retinitis pigmentosa,* central chorioretinitis, the choroidal and retinal lesions of high myopia of detached retina and of disorganized vitreous.

The patient notices quite early in the disease that there is a fixed musca—a persistent speck or dot just outside the visual line. As the disease progresses the number of these paracentral dots, as well as their size, increases until they seem like one large black spot.

The cataract is best seen both by the oblique illumination and by the ophthalmoscope to be distinctly star-shaped; while the parallax test demonstrates that it is situated at the posterior pole or behind the nodal point. Depending chiefly upon the cause of the opacity, post-polar cataract is stationary or progressive. As a rule, it eventually involves the whole lens-body and reaches maturity, although in that event it presents characters that distinguish it, even when it occurs late in life, from the common form of senile cataract.

Cataract, Prevention of. See **Cataract.**

Cataract-pricking. An obsolete term given to the old method of couching of the lens in cases of cataract. A needle was passed into the sclera on the outer margin of the cornea and into the lens, which was then depressed into the vitreous. Those who acquired a reputation for doing this operation were called *cataract-prickers.*

Cataract, Punctate. Blue cataract. Cerulean cataract. This form of cataract is congenital and, as a rule, remains stationary for a number of years. The opacities occur in the form of fine points and generally occupy the center of the pupil.

All forms of punctate cataract are rare. Waldhauer, for example, met with only 2 cases in 900 extractions. Examined by oblique illumination most punctate opacities give a *bluish* reflex, hence the name commonly given to those cataracts, *blue* or *cerulean cataract.*

One of these forms is the *cataracta senilis prematura punctata* of Becker, which commences at 30-40 years of age. This variety has been examined microscopically by Hess. He found that the nucleus is normal, and the perinuclear fibres are also normal, though separated by spaces containing homogeneous or finely granular masses. The spaces are spindle-shaped and may be filled with coagula, though the latter are more commonly elliptical. The spaces may also be elliptical, probably according to the direction in which they are cut. They are most numerous outside the equator of the nucleus, and do not communicate with each other. The coagula stain deeply with hæmatoxylin, brownish yellow with ammonia carmin; they swell up somewhat with hydrochloric, nitric and acetic acids. In Becker's case the fibres showed a wavy contour and there were groups of vesicular cells under the anterior capsule. —(Parsons.)

Recently Hess admits two forms of punctate cataract, one congenital, the other acquired. In some of the cases of punctate cataract reported by others a senile (mixed) form has been described, in which a probable congenital punctate (and otherwise stationary) cataract has exhibited striæ and other opacities of an evidently acquired, senile type.

Cataract, Purse-like. See **Cataract, Cystic.**

Cataract, Purulent. Putrid cataract. A form of (usually) congenital cataract, which takes the shape of a bag of degenerated, liquefied, lenticular fibres that emits an odor when the capsule is opened. See **Cataract, Cystic.**

Cataract, Putrid. See **Cataract, Purulent.**

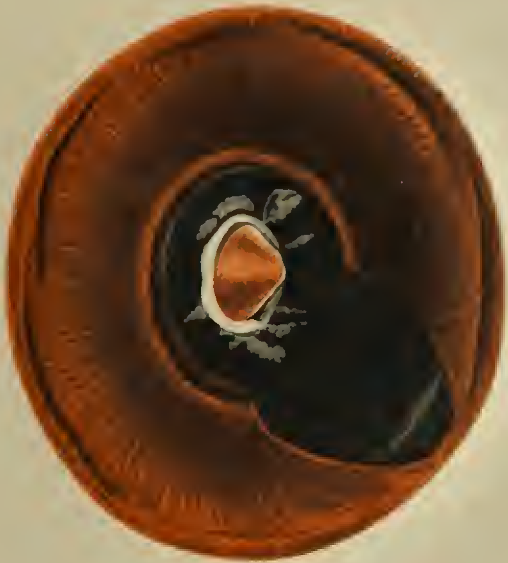
Cataract, Pyramidal. This is a variety of anterior polar cataract. See Vol. II, p. 1463 of this *Encyclopedia,* also accompanying figures).

Cataract, Raphanic. A synonym of cataract from ergot. Weeks (*Diseases of the Eye,* p. 587) gives the following abstract of Kortneff's (*Wjest. Ophth.,* 1892, No. 3) account of lenticular opacities attending an epidemic of ergotism. He observed 500 cases of poisoning; 37 of these patients, ranging from six to fifty-four years of age, had cataract. The opacity of the lens began in the nucleus and spread to the periphery. The cataracts that occurred in young individuals matured in from two to three months; in adults, from eight to twelve months. Extraction was not attended with complications. In spasmodic and in gangrenous ergotism there are violent spasms and cramps, with subsequent contracture which affects non-striated muscular tissue especially. During the spasms the fundus of the eye becomes pallid. In the interval it may be hyperemic.

"Many writers attribute the formation of [ergotinic] cataract to interference with the nutrition [of the lens] due to spasm of intra-ocular blood-vessels. Cataract of this form is almost unknown in the United States."

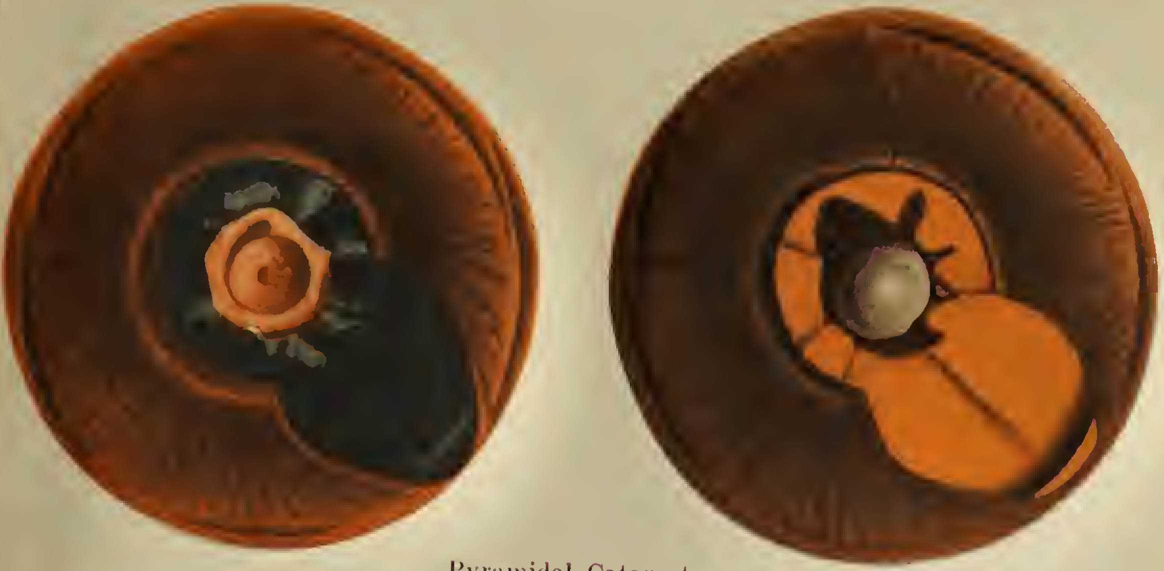
Cataract, Reclination of. See **Cataract, Couching of.**

Cataract, Refraction. Cataract from accommodative efforts. Schoen wrote a monograph (*Die geschichtliche Entwickelung unserer Kenntnisse der Starkrankheit,* 1897) upon this subject. in which he attempted to show that refraction cataract, like tetanic cataract, is due to nutritive



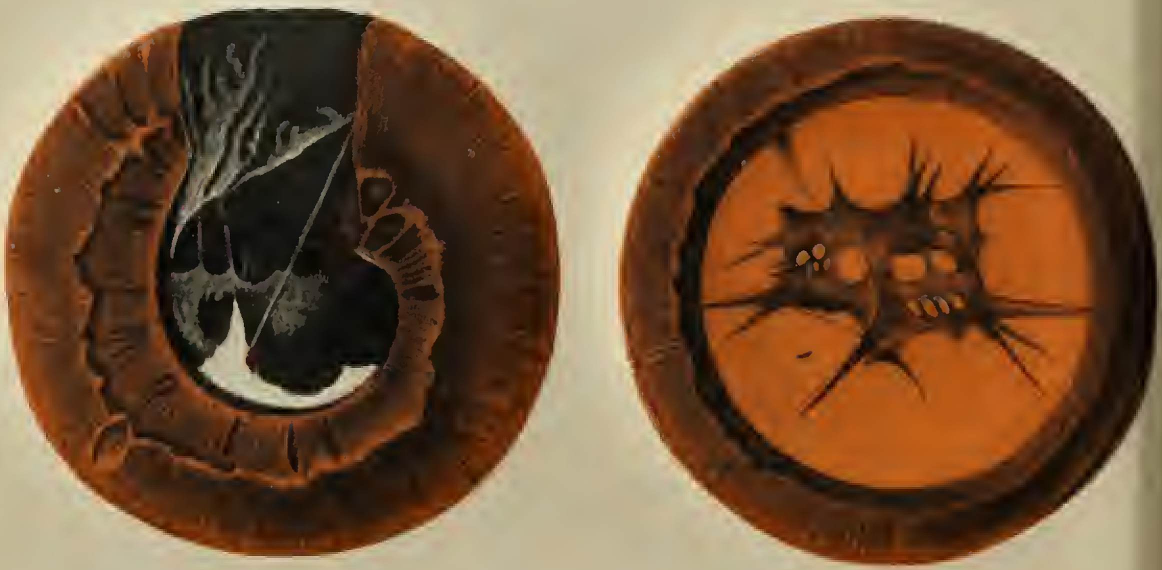
Pyramidal Cataract.

The lateral view with focal illumination. The margin of the lens is seen in the iridectomy coloboma. (After Wintersteiner.)



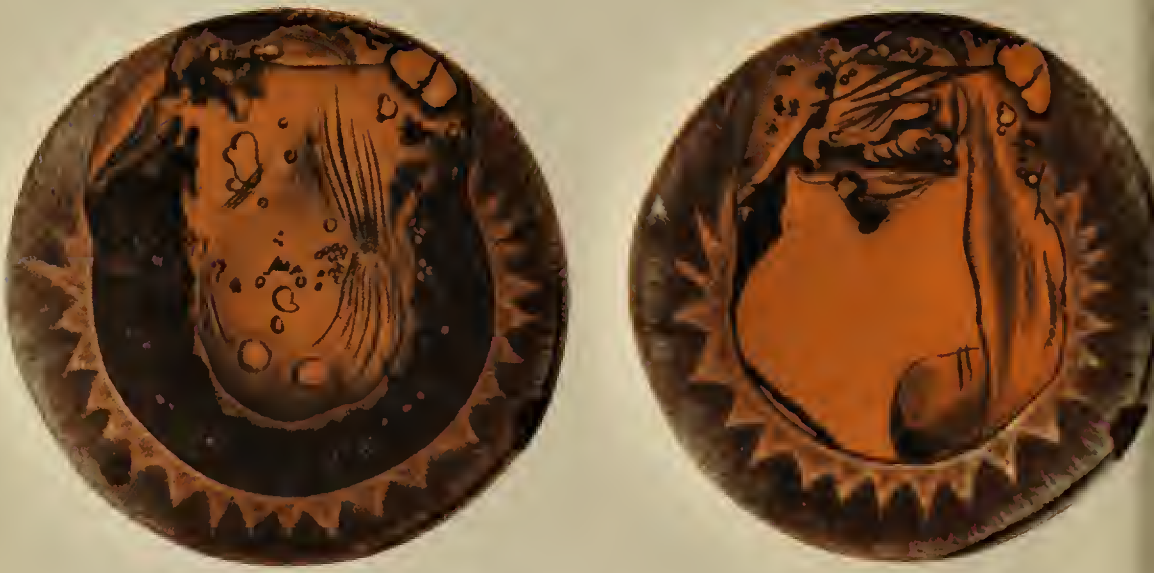
Pyramidal Cataract.

(a) Capsular folds and margin of the lens seen by focal illumination in the artificial coloboma.
The same eye, seen by transmitted light. (After Wintersteiner.)



Secondary Cataract.

(a) After extraction of senile cataract; (b) after removal of traumatic cataract. (After Wintersteiner.)



Secondary Cataract.

(a) After extraction; (b) a month later. Seen by transmitted light. (After Wintersteiner.)

changes in the lens brought about by spasms or cramp of the ciliary muscle fibres in attempts to overcome refractive errors or accommodative anomalies. Of 1202 eyes affected by cataract 34.9 per cent. were hypermetropic; 35.8 per cent., astigmatic; 12.2 per cent., emmetropic; 5 per cent., slightly myopic, and 13 per cent., highly myopic. It was thought by the author of this hypothesis that repeated and unwonted dragging upon and folding of the capsule of the lens (produced by violent and irregular accommodative effort) eventually caused, first, slight, local traumatisms and then cataractous opacities. Georges Martin, Knies and other observers incline towards this belief, but it has not been generally accepted. See, also, **Cataract, Thompsonian.**

Cataract, Retinitic. Dubarry (*Thèse de Paris,* 1869) and Thiray (*Thèse de Paris,* 1875) have dignified the secondary cataract of certain retinal diseases—notably *retinitis pigmentosa*—with a special name. It has long been known that this form of retinal degeneration is frequently followed by a *posterior polar cataract* which *gradually* affects the remainder of the lens, and that when the crystalline becomes entirely opaque and is operated on vision is no way improved.

Cataract from *detachment of the retina,* on the other hand, proceeds quite quickly to completion. The lenticular changes following separation of the retina is of the soft variety; even in adults and senile patients it presents a fatty metamorphosis rather than a sclerosis of the lens fibres. Not only the vitreous but the aqueous humors also appear changed in character, the latter appearing oily, full of shreds and less fluid than usual.

Cataract, Sclerosed. This is the ordinary form of senile cataract, in which the lens-substance undergoes hardening and reaches maturity. Sometimes these cataracts never reach maturity in the ordinary sense, but retain the yellowish appearance of apparent immaturity. They can generally be removed with success, and this should be done if they remain stationary and vision falls below 6/60, or what, by the particular patient, is regarded as useful vision.

Cataract, Secondary. This term is rather loosely employed to indicate a number of totally different conditions. Even the ordinary *senile cataract* is due to various conditions, generally local, that interfere with the nutrition of the lens-system and it, therefore, is in a sense a secondary cataract. Still more decidedly secondary are the lenticular opacities due to trauma, fundal diseases, diabetes, etc., described under **Cataract.**

However, the most common acceptation of the term is *after-cataract,* following attempts at cataract extraction. The simplest form of after-cataract is that in which the loose posterior capsule throws itself into folds or ridges upon which are minute dots. This membrane will often produce an amount of obstruction to the vision entirely out of proportion to its apparent opacity, as seen when looking into the eye with the ophthalmoscope. The reduction of vision is due to the dispersal of the rays of light by the corrugations of the membrane.

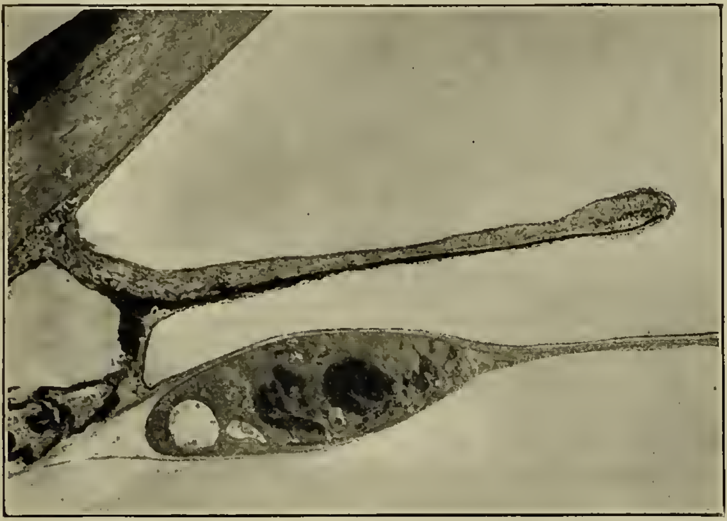
The next and more serious condition is that in which the obstruction is due to opaque masses or bands of tissue lying upon the anterior surface of the capsule. These arise from a variety of causes, being largely due to the fact that the epithelial lining of the posterior capsule which produces the lenticular fibres continues under the new conditions to produce abortive lenticular cells. This is especially true where the anterior capsule overlies the posterior capsule, these cells subsequently becoming sclerosed and opaque.

Another frequent source of after-cataract is small masses of cortical lens-matter that remain behind when the lens is extracted. These subsequently undergo absorption, but at their seat there is found a dense connective-tissue-like material. Bates, from experimental work upon rabbits, drew the conclusion that the fluid which replaced the normal aqueous humor not only contained albumin, but would clot, and that such clots when stained and examined by the microscope showed the structure to be of fibrin. He deduced from these experiments that probably a fibrinous connective tissue process followed on the capsule from loss of the aqueous humor during cataract extraction. It is well known that when the wound of a cataract extraction does not close promptly, so that there is a considerable leakage of aqueous for a number of days, these opacities on the posterior capsule are much more likely to occur. This fact would seem to confirm Bates' deductions.

These opacities very often take the form of bands stretching across the pupil in a direction approaching vertical. The capsule itself is elastic, and these bands tend to contract and draw the elastic membrane tensely across the area of the pupil.

Another variety of simple after-cataract is due to former disease of the capsule itself, in cases of old and complicated cataract.

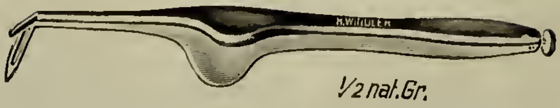
When, following cataract extraction, we have an iritis or an iridocyclitis, the result complicates the simple after-cataract by pouring out upon the surface of the capsule an exudate from the iris. This exudate forms dense opaque masses at the border of the pupil, gluing it to the capsule at such places, and if the iritis has been profound the whole margin of the iris may in this manner be agglutinated to the capsule. The pupillary area becomes much diminished, and if the iritis is complicated with ciliary inflammation in the neighborhood of the original wound, the iris may be drawn up and attached by inflammatory material in such a manner that the lower border of the pupil is dragged to the upper margin of the anterior chamber. The consequent stretching of the iris tissue approximates it to the capsule to which it becomes firmly adherent, with the result that a dense, inflammatory membrane of iris tissue, connective tissue and posterior capsule is stretched across the anterior chamber.—(M. S.)



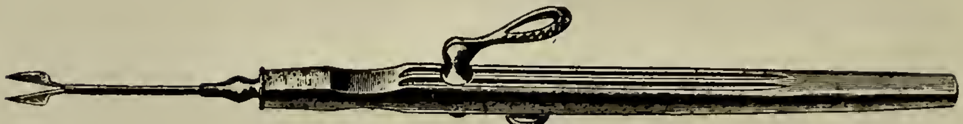
Secondary Cataract with Epithelial Proliferation. (Elschnig.)

Edgar S. Thomson (*Archives of Ophthal.,* May, 1909), believes that secondary membranes are due to: (1) unremoved cortex from the equator of the lens enclosed by apposition of the posterior capsule with the remains of the anterior capsule, and so protected from the solvent action of the aqueous; (2) connective tissue formation from iris fibroblasts due to iritis, slight or severe.

The unremoved cortex invariably increases in volume by proliferation and may become infiltrated with leucocytes and fibroblasts. Later, the mass undergoes retrogressive changes, resulting in connective tissue formation and contraction. These contraction bands, hidden behind the iris, exist very frequently. They do not necessarily give rise to trouble, perhaps because the changes are slow, and our patients often old, but they may (1) pull on the ciliary body causing those apparently spontaneous attacks of cyclitis which occur with a clear pupil, and which even go on to glaucoma; (2) relax the membrane so that it wrinkles, and causes irregular refraction of light rays; (3) form, when accompanied by slight iritis, the well-known connective tissue membranes of varying density across the pupil.

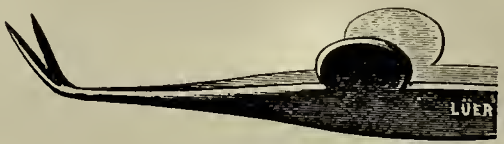


Linde's After-Cataract Scissors.

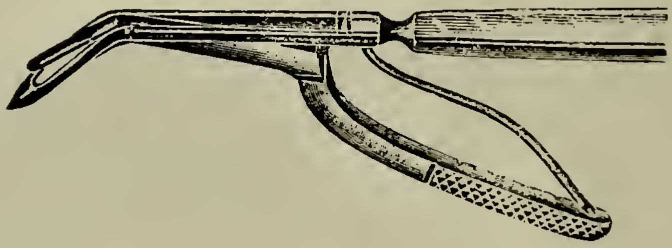


Secondary Cataract Instrument of Lüer.

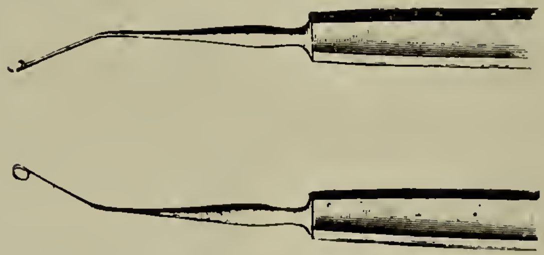
It is entered while closed, the secondary membrane is pierced by the arrow-pointed end, the blades are then opened wide and a cut made through the obstruction to vision.



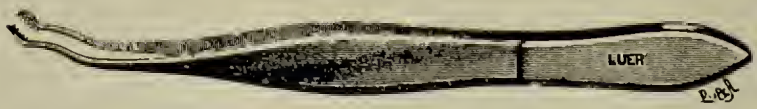
Levinsohn's Forceps-Scissors for Secondary Cataract.



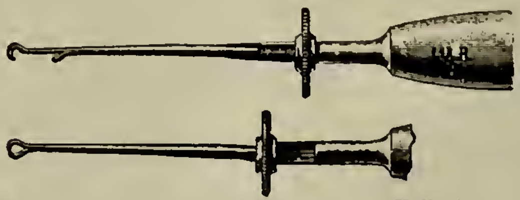
Secondary Cataract Instrument (Punch) of Krüger.



Weber's (Right and Left) Capsule Hooks, for the Extraction of Capsular Remains.

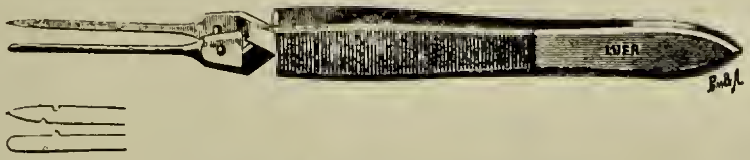


Pley's Capsular Forceps, for Secondary Cataract.

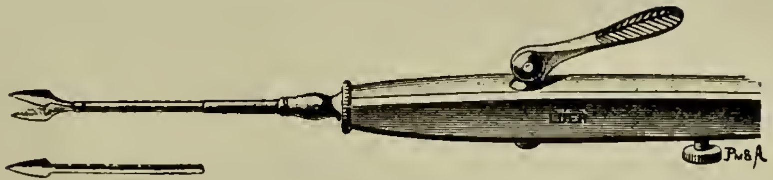


Guarded Hook (Panas) for Removing Capsular Débris in Secondary Cataract.

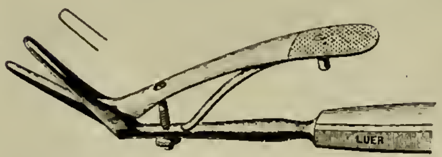
To counteract these evil consequences he advocates making as large a crucial incision with the cystotome as possible, to expose the cortex thoroughly to the aqueous; washing out the capsule after every extraction; and controlling inflammation of the iris as far as possible by the early and judicious use of ice and atropine. His after-treatment of the opaque membranes is on the usual orthodox lines, but he points out that it is advisable not to judge the density of the membranes only by the appearance, but to consider also the amount of iritis that followed the extraction, the amount of cortical material that was left to be absorbed, and the length of time since the extraction.



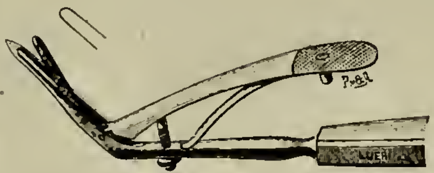
Bourgeois' Capsulectomy Forceps.



Wilde's Capsular Scissors for Secondary Cataract.



De Lapersonne's Capsulo-iridotome.



A Punch for Use in Secondary Cataract.

Operative treatment. Linde has invented a modified de Wecker's scissors in which a short, blunt pointed but cutting blade fits into a longer pointed one. A small corneal wound is made with a keratome in such a fashion that no aqueous escapes. The point of the keratome should at the same time make an opening in the after-cataract. The closed instrument is now introduced through cornea and cataract, and, *on opening*, it makes easily and without irritating the iris, a clear pupillary space.

Bourgeois' capsulectome is an instrument intended to be used in operating on secondary cataract, especially that found after extraction without iridectomy, the obstructing membrane being removed by a combination of siezure, cutting and torsion; *not* by dragging or pulling. An opening 3 mm. wide is made with a keratome or similar instrument, and the point of the capsulectome introduced closed. It is now opened by simple pressure on the branches of the instrument until the margin of the pupil is reached by the blades. They are then allowed to close, when it will be found that a portion of the opaque membrane is caught between them. The instrument is then slowly withdrawn from the anterior chamber with a rotary movement, when the opaque capsule included between the blades will be cut off and removed without damage to the iris.

For the *treatment,* generally operative, of this condition, see, also, **After-cataract.**

Cataract, Senile. Under the general heading of **Cataract,** the *symptoms, prevention* and *non-operative treatment* of *senile cataract* have been to some extent considered, but it is proposed in this section to say something more not only on these topics but on others connected with the subject that have been referred to there and elsewhere. The classic work of Otto Becker (*Zur Anatomie der gesunden und kranken Linse,* 1883), or the later monograph of Louis Stricker (*The Crystalline Lens System,* Cincinnati, 1899) based on it should be consulted by the reader as an introduction to the study of senile cataract. In recent years other treatises (by Greeff, Parsons, Treacher Collins, Dor, Hess, Herbert) are at hand to supplement these earlier works.

Hard or senile cataract, gray cataract, is the commonest as well as the most important form of the disease, the cortical variety being most frequent.

The normal lens gradually grows larger and denser as we grow older and exhibits other senile changes; the lenticular nucleus in particular becomes firmer, and with the rest of the lens acquires a yellowish tint and transmits less light than formerly.

One should not assume from the name commonly given to this form of crystalline opacity that it represents a change more or less normal to increase of years—like gray hair or wrinkles—but that it is always a disease and generally a serious disease with definite pathological lesions. However, since these changes are rarely encountered before the age of fifty it is, and has long been, an established custom not to speak of opacities in the lens as *senile* when they appear prior to that age.

The *pathology and morbid anatomy* of senile cataract has been discussed in Volume II, p. 1447 of this *Encyclopedia.* Louis Dor believes this form of acquired cataract to be due to hydration of the lens and, in consequence of this process, absorption and disappearance of the soluble crystalline albumins. This degenerative process is in its turn due to certain causes producing hydration by the flowing of a watery current into the lens substance through a form of (morbid) osmosis. This double process, when it is not attributable to a modification of normal physical conditions (excessive heat, light, electricity) is the result of penetration into the lens substance by watery ferments or cytolythic serum. This penetration is made possible by certain changes in the subcapsular cells, often corresponding to alterations in the epithelial structure of the ciliary body. Black cataract is a phenomenon of oxidation rather than of hydration. In those senile cataracts whose nuclear coloration is yellowish, brown or black, but in which the cortex appears white, there is both dehydration and oxidation.

W. E. Burge (*Archives of Ophth.*, Sept., 1909) has analyzed the ash of both normal and cataractous lenses. Tables giving analysis of the normal human, the pig's, and of cataractous lenses are reported. The pig's lens was found to be almost identical in the percentage of the ash with the normal human; and most of the comparisons are drawn from this and the human cataractous lens.

Burge concludes that in senile cataract the percentage of potassium is greatly reduced, while calcium and sodium are increased, thereby bringing the lens nearer to the composition of the blood and the lymph. He also finds that the normal lens in old age compared with the embryo does not show any percentage diminution of potassium. From this the author argues that senile cataract is not premature senility of the lens. i. e., the acceleration of the normal senile change; but is due to some cause which has interrupted the normal metabolism, and brought on a moribund condition of the tissue. As a confirmation of this theory is the curious fact that the cataractous lenses obtained from India contain a large amount of calcium, potassium and sodium silicate, while those from the United States are without silicates. Is there something in the diet of the East Indians to account for this curious condition?

A. E. Elschnig (*Klin. Monatsbl. f. Augenheilk.*, January, 1911) has recorded the *morphologic conditions* of lenses extracted for senile cataract; in all 224. They were placed in a white porcelain dish, filled with physiologic salt solution, with a black glass plate, graduated in millimeters, at the bottom. By alternately bringing the lens, with a cataract spoon, on the white or black part of the bottom the transparency of cortex and nucleus could be sufficiently well ascertained.

A general examination of all cataract patients is made by Elschnig, and only uncomplicated senile cataracts, with a lowest age limit at 45 years, are considered in the following 6 groups: 1. Total cataract with grayish-yellow or white nucleus and more or less uniformly opaque cortex of grayish or yellowish-gray color. 2. Brownish or brownish-gray nucleus with more or less dense grayish or yellowish-gray cortex. 3. Cataracta (brunescens) nigra. 4. Pure cortical cataract without visible nuclear opacity. 5. Opacity of the cortex similar to zonular cataract with clear nucleus. 6. Pure opacity of the nucleus, nuclear sclerosis, the cortex being perfectly transparent or with very faint spokes at the surface. 1 and 2 correspond to the subcapsular cataract of Hess, with the difference that the nucleus is also opaque. The great frequency of nuclear cataract in the above named writer's statistics is due to the fact that he entirely excludes the so called "maturity" of cataract from the indication for operation. In clinically pure sclerosis of the nucleus the latter showed the faintest gray coloration or opacity on transillumination with the plane mirror. After extraction Elschnig considers the examination of opacities of the lens *in vivo,* as long as they are partial, with the plane mirror and loupe far superior to any other mode, even to that with the corneal microscope. No relation between age and form of cataract could be ascertained, although it seemed that total cataract with brownish nucleus usually occurred in older individuals, and that cataract with gray or white nucleus occurred more often in younger ones. Elschnig confirms the observation of Handmann that senile cataract almost regularly commences in the lower half of the lens.

The author proposes the following modifications of Hess' nomenclature of cataract: 1. Cortical cataract without opaque nucleus, subdivided into subcapsular and supranuclear cortical cataract. 2. Nuclear cataract, frequently commencing as sclerosis of the nucleus. Both forms are not stationary and may pass into 3, the regular senile total cataract with its regressive metamorphosis: finally cataracta brunescens, or nigra. The term "incipient cataract" is to be discarded and replaced by the correct signification of the form of cataract: nuclear (cortical), subcapsular and supranuclear; finally, incipient, total, where the epithet "senile" would specify the etiology.

Later, Elschnig and Zeynek (*Wien. Klin. Woch.,* January 10, 1913) report that among 1,500 cataract extractions, in the last five years, there was only one case of cataracta nigra, and seven cases of cataracta brunescens. The lens of cataracta nigra was very hard. The outer lamellæ were colorless, the inner ones yellowish brown and transparent. They became entirely transparent after treatment with glycerine; microscopically no pigment corpuscles were observed. This fact probably induced some authors to consider the coloring of cataracta nigra to be due to an increased density and sclerosis of the lens fibres. There, however, was possible with a 3 per cent. solution potassium hydrate to extract a brown pigment. It is probable that this pigment is produced by a change and destruction of some albumen corpuscles brought about by digestive disturbances.

W. Reiss has endeavored (abstract in *Ophthalmology,* Oct., 1913, p. 109) to establish the histological differences between the mature and the immature fibres of senile cataract by a chemical test. However, he regards the maturity of cataract as mainly a clinical conception, and agrees with Landolt that we should substitute for the *maturity* of a lens, the idea of its *operability.*

The pathological examination of lenticular opacities is fraught by many difficulties. There has not yet been found a reliable liquid for preserving and fixing the lens, which constantly loses its form, dimensions and structure. Cataracts obtained for histological purposes by operative means are usually minus their capsule, whose epithelium is one of the starting points of cataract and an important seat of pathological lesions.

For the better determination of the state of maturity of senile cataract, Reiss resorted to the cysteinic reaction discovered in 1910 by Arnold and used in the biochemical examinations of various albuminoid bodies in the human organism. His method is as follows: Crush and spread upon a piece of blotting paper by means of a spatula, the lens to be examined. After drying in an oven, a few drops of a 5 per cent solution of nitro-prusside of sodium are added. When this thin film is touched by a glass rod dipped in ammonia there is produced—in the normal lens—a deep purple color. In unripe cataracts, the opaque particles do not give this color reaction. Reiss, relying upon his numerous investigations, concludes that a negative result of the cysteinic reaction in the cortical masses as well as in the nucleus constitutes a valuable objective sign of the maturity of senile cataract.

A. Jess (*Archives of Ophthalm,* Jan., 1913) has added a number of observations to the researches of Reiss. He finds that in the normal lens there is no difference in the behavior of the peripheral and of the central layers to this reaction, and that in senile cataract the reaction disappears entirely or in part. Traumatic cataract behaves like a normal lens. In hypermature cataract, the reaction is entirely wanting. In immature cataract the cortex nearly always reacts plainly, and even in some cases the nucleus also. The age of the patient has no effect on the reaction. Jess is also able to confirm Morner's statement of the presence of a considerable amount of insoluble albumin in the lens.

It is known that cataract in a person having a blue and a brown eye (heterochromia iridis) always develops in the blue eye; or if the eyes be of the same color and the iris of one be lighter in shade than the other, that it first attacks, or may attack only, the lighter-colored eye. Fuchs believes that in the absence of other causes, this must be regarded as something connected with the lack of pigmentation in the lighter eye; it being assumed that a disturbance of nutrition is at the bottom of both morbid conditions. It is true that nothing more definite than this is known regarding such a disturbance of nutrition; but that it is present is clear from the fact that in the lighter-colored eyes we [nearly] always find the evidence of a chronic cyclitis in the form of very minute deposits.

The alterations in the crystalline lens that one finds in hard or senile cataract are at first generally confined to the cortex; the nucleus and peripheral epithelium are later involved. A clear fluid, coagula and Morgagnian globules are found between the unaltered fibres, so that even if there be shrinking of the nuclear portion, the cataractous lens is often larger, as a whole, than normal. Alt believes that some of the intraocular fluid finds its way through the capsule between the lenticular fibrils, and that the wedge-shaped opaque areas are due to the arrangement of the lens-star. So far as the microscope is concerned it reveals in the earlier and medial stages of hard cataract; vesicular cells, Morgagnian globules and coagulated deposits, as well as fibres that are spindle- and club-shaped. Although there may be no alterations in the epithelium, yet the fibres at the equator are often destroyed early, so that the degenerated cells extend towards the posterior capsule and even line it. As the morbid changes proceed the spaces between the fibrils become filled with coagula, large irregular spaces are formed and at last the whole cortex is converted into an opaque mass. Finally, cholesterin and chalky material may be deposited. A portion of the lens matter becomes absorbed, the contents may fall away from the capsule and the subcapsule space filled by a thin layer of fluid. Clinically, the cataract is then said to be *mature* or *ripe*.

In hypermature cataracts there is often thickening of the anterior capsules, due to proliferation of the anterior epithelium. Still later, the lens substance may become absorbed and replaced by fluid, in the midst of which the nucleus floats free—thus constituting *Morgagnian cataract* (q. v.).

As a consequence of these changes cataractous lenses vary greatly in diameter—a matter of much importance in connection with the length of the incision for their removal. It must be remembered that this diameter is rarely less than 10 mm. in the ordinary form of opaque lens.

Handmann (*Klin. Monatsbl. f. Augenheilk.*, Dec., 1909) has made a point of recording exactly in all cases of cataract the nature of the opacity, its position as regards cortex, nucleus, pole or equator, and, in the case of peripheral opacities, the segment of the lens in which they were situated; and made the discovery that the first indications of senile cataract appeared with much greater frequency in certain quarters of the lens periphery than in others.

His figures concern 845 eyes with senile cataract, in which the opacity could be called incipient in the sense that some portions of the lens were still transparent; there were 1147 opacities or groups of opacities, which were distributed in the regions of the lens in the following manner: Lower, 335; lower nasal, 118; lower temporal, 35; upper, 32; upper nasal, 14; upper temporal, 15; nasal, 111; temporal, 67; diffuse, 65; whole periphery, 89; central, 220; supranuclear, 26; doubtful, 22.

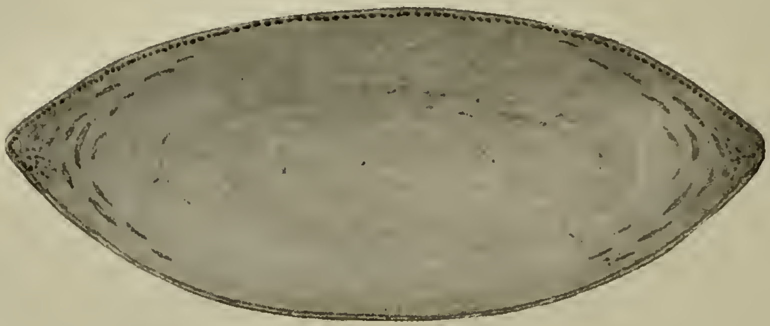
Excluding the more advanced cases and taking only those which presented no more than one or two opacities, with normal or nearly normal visual acuity, the figures were for 391 peripheral opacities: Lower, 319; upper, 21; nasal, 40; temporal, 11.

Having thus shown the marked preponderance of the earliest signs of senile cataract in the lower half of the lens he discusses the inferences which may be drawn from the fact. We know that adventitious substances, such as blood and pus, tend to collect in the lower part of the anterior chamber, and we may assume that pathological products and excreta so far as they are specifically heavier than the aqueous will take the same position, and the lower half of the lens will thus be less favourably situated as regards metabolic changes than the upper. Another possible factor in the production of senile cataract is the influence of the ultra-violet rays on the lens. Such rays have been shown by Widmark, Hess and others to be capable of producing destructive changes in the lens fibres (as well as in other tissues of the eye) and it is obvious that in the ordinary occupations of life the lower, and perhaps especially the lower-inner, parts of the periphery of the lens will be more exposed to light rays than the upper.

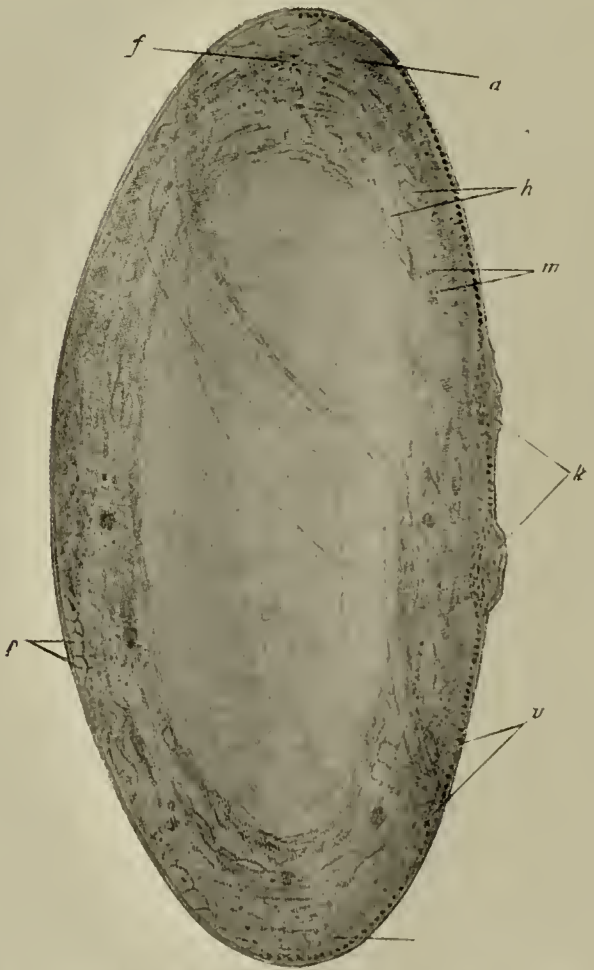
Taking these facts in conjunction with his present observations Handmann is inclined to view the latter as a proof that senile cataract arises from certain disturbances of the nutrition of the lens which make themselves felt more readily in the lower than in the upper part of the lens.

Do cataracts due to other causes show a similar localization? The author's figures bearing on this point are naturally much smaller than those for senile cataract, but so far as they go he considers that his statistics for diabetic and glaucomatous cataract show that the changes in the lens in such cases are more apt to be diffused and exhibit no marked preponderance in any particular region. (Abstract, *Oph. Review,* May, 1910.)

Classification of senile cataract. Axenfeld (*Lehrbuch der Augenheilkunde,* 3rd Edition, p. 504) and some other writers divide the various



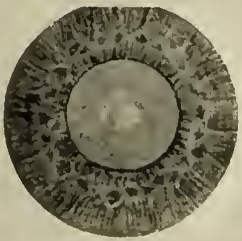
Incipient Subcapsular Senile Cataract. (After Axenfeld.)



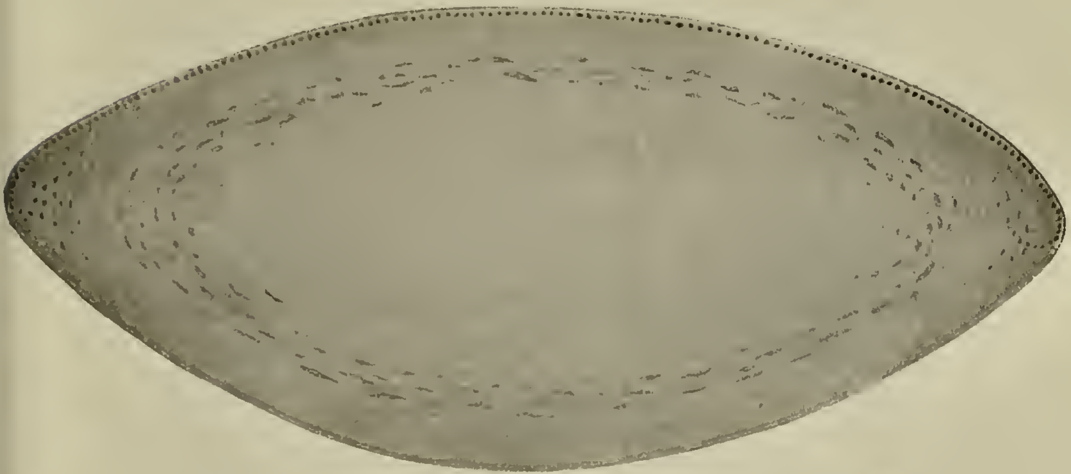
Mature Subcapsular Senile Cataract. (After Axenfeld.)

d, Fine-celled débris; *f,* free cells; *h,* empty spaces (or filled with clear fluid) between the lens fibres; *k,* capsular cataract; *m,* Morgagnian granules; *p,* false epithelium on the posterior capsule; *v,* clear spaces between the capsule, epithelium, and normal lens fibres. The nucleus of the lens is normal.

forms of senile cataract into sub-varieties, although they admit that these forms are very often combined or gradually shaded off the one into the other. The Axenfeld subdivision is into (a) *subcapsular cortical cataract,* (b) *supranuclear senile cataract,* and (c) *nuclear senile cataract.* The most common form is the subcapsular, divided into four categories, according to the progress made by the advancing opacity, into (1) *cataracta subcapsularis incipiens,* (2) *cataracta subcapsularis immatura,* (3) *cataracta subcapsularis matura,* (4) *cataracta subcapsularis hypermatura.* These different forms are pictured in the text.



Hypermature Subcapsular Senile Cataract. (After Axenfeld.)

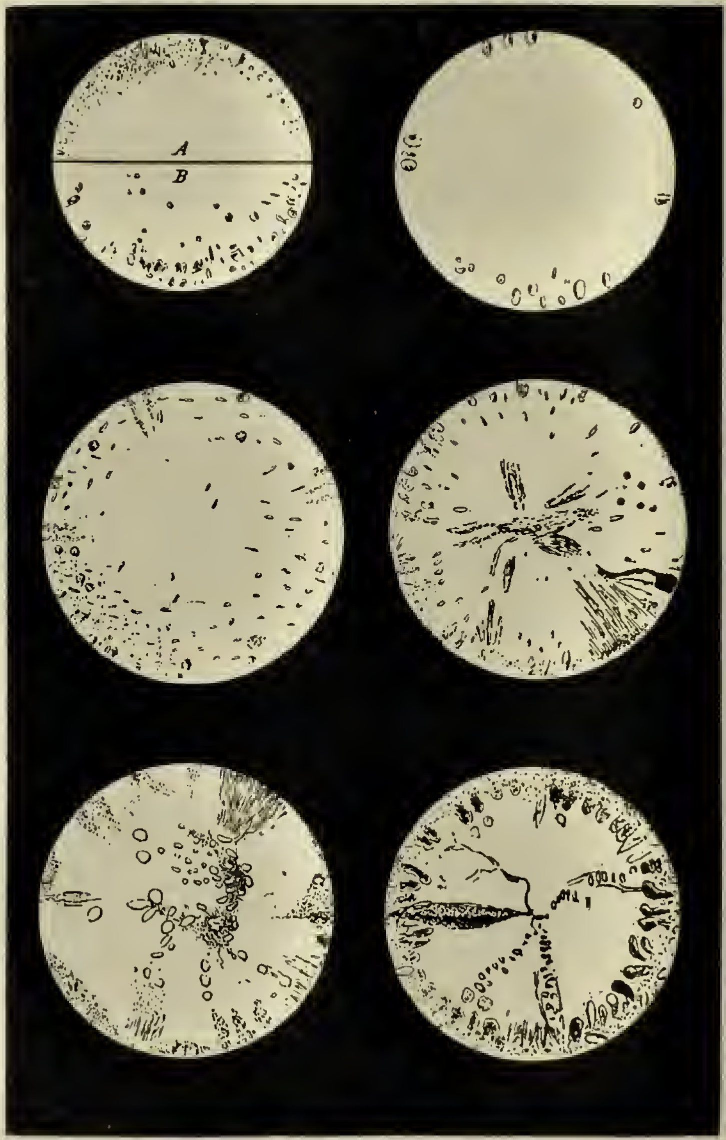


Supranuclear Senile Cataract. (After Axenfeld.)

Diagnosis. If the patient be examined by *skiascopy* the shadow will often be found irregular and indistinct, corresponding to the unequal refraction of the different parts of the disturbed crystalline. The fundus-reflex movements will be seen to gyrate, be semi-rotary, or go through various other kaleidoscopic movements in correspondence with the diffractive and other effects produced by irregular lenticular astigmatism.

The *ophthalmoscopic* examination will also give varying results according to the degree of fibrillar (and especially central) involvement. For the study of minute cataractous changes the direct examination with the mirror and strong plus lenses (10 to 20 dioptries) furnish the best information. The various figures shown in the accompanying cuts are from the work of Magnus, who found that of 166 cases the alterations began in the equatorial zone in 92, or 75 per cent.; only 8 per cent. in the nuclear area.

Perhaps the majority of peripheral opacities in the lens substance show themselves (1) as *gray striæ,* more or less large, stretching from the equator sometimes towards the anterior, sometimes towards the posterior, areas and slowly advancing toward one or other pole. Through the dilated pupil this form of progressive senile cataract exhibits a delicate sort of crown about the whole crystalline. The cataract having proceeded thus far may remain *stationary* for a long time.



Some Ophthalmoscopic Pictures of Senile Cataract. (Magnus.)

Von Ammon gave this picture the name *gerontoxon lentis.* Generally, however, the remaining clear fibres are involved until the cataract becomes mature.

A *second* type of incipient senile cataract appears as a vail of irregular, isolated, whitish or grayish spots. Occasionally these opacities follow the arrangement of the lens fibres at the anterior pole and form a stellate figure in this situation. A *third* form begins at the nucleus to which it may be confined a long time before it involves the periphery of the lens. We speak of this as *nuclear* cataract, although anatomical examination proves that this form of cataract in its early stage is really *perinuclear* and that the actual nucleus—hidden from view—is generally not affected in this type, or, at least not until the whole crystalline is involved.

Prognosis. It is impossible to do more than guess at the future progress or rate of progress in any senile, non-stationary form of cataract; the remaining transparent fibres may become opaque in a few days, a few months, a few years, or not during the lifetime of the patient. Some light may, however, be thrown upon this subject, of such great importance to the patient, by advising him to return in from three to six months when the date of maturation (or operation) may be estimated from the rate of progress made by the cataract meantime. This can be determined chiefly by a comparison of the lens picture drawn at the first interview with its appearance at the subsequent examination. Changes in the lens may also assist one to decide whether the lens is making definite advances toward maturity. In the latter case the swelling of the lenticular fibres causes the shallowing of the anterior chamber, pushes the iris before it and interferes with the free movements of the latter. The pupil now dilates and contracts with greater difficulty. As soon, however, as it becomes ripe the lens mass begins to contract, the anterior chamber recovers its nominal depth, the pupillary movements are more regular and less constricted and the proper time has arrived for surgical intervention. .

If the mature senile cataract is not removed regressive changes sooner or later occur, and we have a *hypermature cataract.* These late alterations may take several forms. *First,* the cortex undergoes hardening, as if the early sclerotic changes in the nucleus had gradually invaded the periphery of the crystalline. These cases occur chiefly in patients over 70 years of age, or in those who have deferred operation years after the maturation of a perinuclear (senile) cataract. When these cases come to operation all the fibres of the lens —cortical and nuclear—adhere intimately and the cataract "shells" out leaving perfectly clean capsules. This form of hypermature cataract belongs to the class that is removable by any form of operation and in the hands of any operator. To this class, also. belongs *brown* cataract, so often called *black*. They have almost always a translucent cortex; in fact as the cortical portions of this hypermature cataract hardens it seems to regain some of its transparency, so that patients affected by it often continue to count fingers at one or two metres, or even greater distances. Over-ripe cataracts of this kind do not respond to the shadow-of-the-iris upon the lens test (see *diagnosis*), and if the observer were to wait for the disappearance of the shadow he would never operate on the patient. Indeed, hypermature, brownish cataract has often led to suspicion of hemorrhage into the vitreous. They are quite rare, although they were recognized and described by all the early ophthalmologists. Rolfink speaks of a case in 1664; Janin (of Lyons) removed one in 1774; Lawrénce saw one case in 1200 extractions.

A *second* variety of hypermature cataract is that in which there is complete degeneration of all the crystalline fibres, which are converted especially into myeline material, detritus, oily granules. cholesterine crystals, and calcareous particles.

A *third form* of over-ripe cataract is seen when the cortical masses soften, liquefy and are transformed into a yellowish-gray or even milky-white fluid. The outlines of the cortex disappear; here and there are yellow or white points, or the whole surface appears whitish, especially at the lower margin of the dilated pupil. and we have the liquid form of the hypermature cataract—commonly described under the term *Morgagnian cataract* (q. v.). In these rather rare cases, if the patient be instructed to look quickly in various directions a small yellowish body will be seen to roll about within the field of the pupil. This is the hard nucleus of the lens which has resisted almost to the last the liquefying process and sinks out of sight when the eye is quiet to the bottom of the sac formed by the still intact capsules and the ''milk'' of its cataractious contents.

Many senile cataracts are of the *diabetic* type, although the exact proportion published by observers varies greatly. Becker gave it as 1 per cent.; Williamson 8 per cent.; Funke 5 per cent.; Koenig 11 per cent. It may be well to add to the remarks under diabetic cataract (q. v.) that in many cases of senile diabetes lesions of the epithelial cells of the ciliary body are present, which in turn interferes with the proper nutrition of the lens and produces cataract. The researches of Koch in 1899 and of Vinsonneau in 1904 demonstrate that it is not so much the mere presence of glucose in the intraocular fluids (0.20 to 0.50 per cent.) as the vicious influence of the diabetic state on the whole uveal tract that brings about the changes in the lenticular fibrillæ.

Diabetes as a cause of cataract was first reported by Berndt as early as 1834, and since his day observers have divided on the question of the actual cause of the crystalline changes. One division gives what seems the most simple explanation of the cataract, viz.; the unnatural presence of sugar in the blood and intraocular fluids; i. e., the glucose cataract is like the naphthalin cataract—both may be induced artificially and both are of toxic origin and character.

The second division deny this and regard the lens changes as largely coincidental, or at least only indirectly due to the diabetic condition. However, recent investigations have turned inquiry into other channels; for instance, what causes the ciliary alterations that produce the cataract? What interferes with the secretory action of the ciliary epithelial cells, those analogues of the renal cells? Is it glucose in the blood or a deeper agency of which sugar formation is an incident? Even the experiments of Magnus, who produced cataract in the lower animals by the injection of glucose, does not throw much light on this problem.

Hayashi (Graefe's *Archiv für Ophthal.*, Vol. 76, part 1, 1910) gives an account of researches undertaken by him with a view of obtaining experimental evidence upon the liability of the eye to infection during or after operation, in the subjects of diabetes mellitus.

Cataract being the most frequent and one of the most serious of the ocular complications of diabetes, and one which is remediable by surgical interference, it is of great practical importance to know to what extent the prognosis after operation is modified by the existence of glycosuria.

Hayashi's experiments show, as far as experiments can be conclusive as regards man, that the eye of a diabetic is decidedly more prone to infection during an operation, than is the eye of a healthy person. Although experimental results indicate that it is most desirable to obtain a complete absence of sugar in the urine before operation, the experience of operators tends to show that it is not always advantageous to adopt a rigorous anti-diabetic regimen with a view to the complete disappearance of glycosuria. The increased predisposition of diabetics to infective processes, and their diminished power of resistance to pathogenic micro-organisms clearly demonstrate the urgency of very strict asepsis in operations upon diabetics, and especially in extraction of cataract.

Uhthoff's well-known experience of diabetic cataract, especially in its operative relations, is given in the *Bericht der Oph. Gesellschaft*, for

1910. This communication is reviewed in the *Oph. Review,* June, 1910. The surgical results obtained by Uhthoff are very satisfactory, much more so than those recorded in some earlier papers; they will in fact compare not unfavorably with the results of cataract extraction in non-diabetics.

Uhthoff finds that about 5 per cent. of all his cataract extractions are in diabetics; and that of his total number of cases of eye disease "diabetic cataract" is not met with in 0.12 per cent. Presumably he uses the term diabetic cataract in a wide sense, meaning thereby all examples of cataract occurring in patients with glycosuria.

The proportion of cataract operations in diabetics to those in non-diabetic patients was much higher in his private than in his hospital practice. This is probably the experience of most ophthalmic surgeons.

In reference to technique and after-treatment in these cases Uhthoff has practically followed his usual routine. He is not in favor of a strict anti-diabetic regimen before or during operative treatment in patients who have not been previously on a special dietary. As in non-diabetic cases, he orders absolute rest in bed for one day, and allows the patient to sit up in a chair from the second day onwards. His usual method of operating is by a peripheral flap section with a conjunctival flap. He does not perform preliminary iridectomy, and as a rule he now does a simple extraction, instilling a half per cent. solution of eserine at the termination of the operation. In his earlier cases he performed extraction with iridectomy, but recently has relinquished this method in favor of simple extraction. Since the regular application of eserine after the operation he has had very little trouble with prolapse of the iris.

The total number of cases operated upon by Uhthoff was 115, and of this number not one eye was totally lost, although in two instances no useful vision was regained, one patient having only p. l., and the other being able to count figures at 1 metre. The former of these two cases occurred in a man who had arterio-sclerosis, albuminuria, and gangrene of one leg. One patient, a woman aged 42, who was doing well surgically, died on the fifth day of diabetic coma. In this case no serious disturbance of health had been noted before the operation was undertaken.

The following are the percentage results of vision in the 115 cases:

Vision 1 to ⅓	68 per cent
Vision ¼ to 1/10	18 per cent
Vision less than 1/10	14 per cent

One of the most frequent complications was iritis; this occurred in a severe form, sometimes accompanied by hypopyon, and in a mild and easily controlled variety, the former being the more common. Maceration of the pigment layer of the iris was a marked feature in these cases, the iris afterwards showing the characteristic appearance first noted by Snellen. This alteration in the pigment epithelium did not appear to have any serious effect on the healing of the tissues.

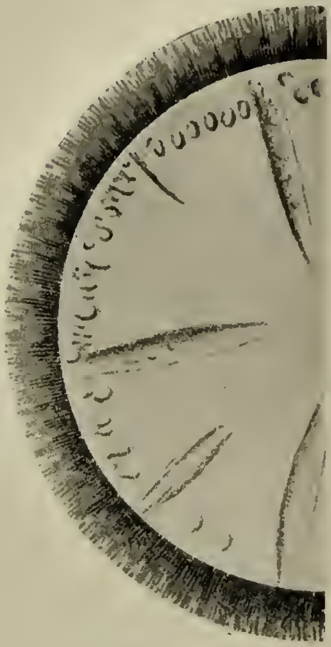
In the following table are given the percentage occurrence of the more important complications in Uhthoff's series:

Severe iritis (3 times with hypopyon)	6 per cent
Mild iritis	5.4 per cent
Post-operative glaucoma, after retinal hemorrhage	0.9 per cent
Detachment of choroid	0.9 per cent
Hemorrhage in ant. cham.	8.9 per cent
Retinal hemorrhage	4.5 per cent
Hemorrhage into the vitreous	1.8 per cent
Diabetic retinitis	2.6 per cent
Albuminuric retinitis	0.9 per cent

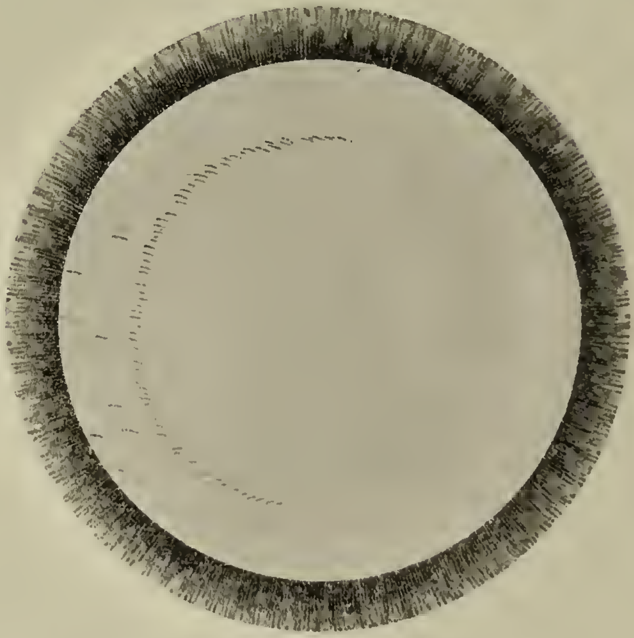
Dor (*Encyclopèdie Française d'Ophtal.*, VII, 215) thinks that true diabetic cataract *does* exist but since it appears at various ages it occurs in many different forms as soft cataract, rapidly affecting the whole lens in the serious and generally fatal glycosuria of young subjects; later as a mixed variety in adults and, finally between 45 and 60 as ordinary senile cataract.

In addition to these characters due to the age of the patient diabetic cataract possesses others which enable us to distinguish it apart from the urinalysis. The chief of these is the rapid development of the opacities which, especially in children, may involve the whole lens in a few days or weeks. The progress of the opacification is much less rapid in adults and old subjects but as compared with the progress of other forms of senile cataract is unusually rapid, maturation (including the cortex) occurring, even in persons above 50, in a few weeks or a month or two.

The well known *weakness of accommodation* in diabetics must not be forgotten in dealing with their cataractous troubles, and the presence of marked accommodative asthenopia should make us suspect the glycosuric character of any lenticular cloudiness. Schmidt-Rimpler measured the amplitude of accommodation in 80 diabetics. In 14 per cent. it had diminished more than 2D.; in 6 per cent 4D.; and more when, of course, it became a true paresis. Naturally this weakness is more marked in the young hyperopes affected by diabetes than in presbyopes.



Senile Cataract Beginning at the Equator of the Lens. First Type (Magnus).

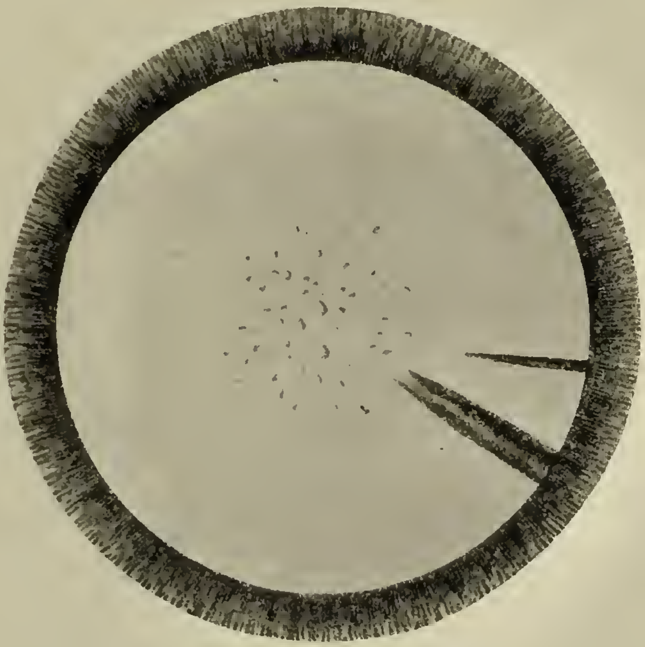


Senile Cataract Beginning at the Border of the Nucleus. Second Type (Magnus).

Different observers place the proportion of diabetic cataracts to other forms at from 2.35 to 5 per cent.

It may be repeated here that cases of spontaneous cure or disappearance of incipient senile cataract occur after non-operative treatment in a much larger proportion of diabetic cataract than in those of other forms.

Appearance of senile cataract. With pupil well dilated the grayish, translucent outline of the whole lens is clearly seen, both with oblique illumination and by reflected light. While these changes, due to old age, may be regarded as more or less physiological, they are closely allied to true cataract. In the latter instance, however, delicate lines, or well defined streaks of opacity, best seen by reflected light with a dilated pupil, add themselves to the normal translucent gray of the lens. These commonly begin at the periphery or equator, and slowly invade both cortex and nucleus until the whole crystalline is involved.



Senile Cataract Beginning (Chiefly) at the Anterior Pole of the Lens. Third Type (Magnus).

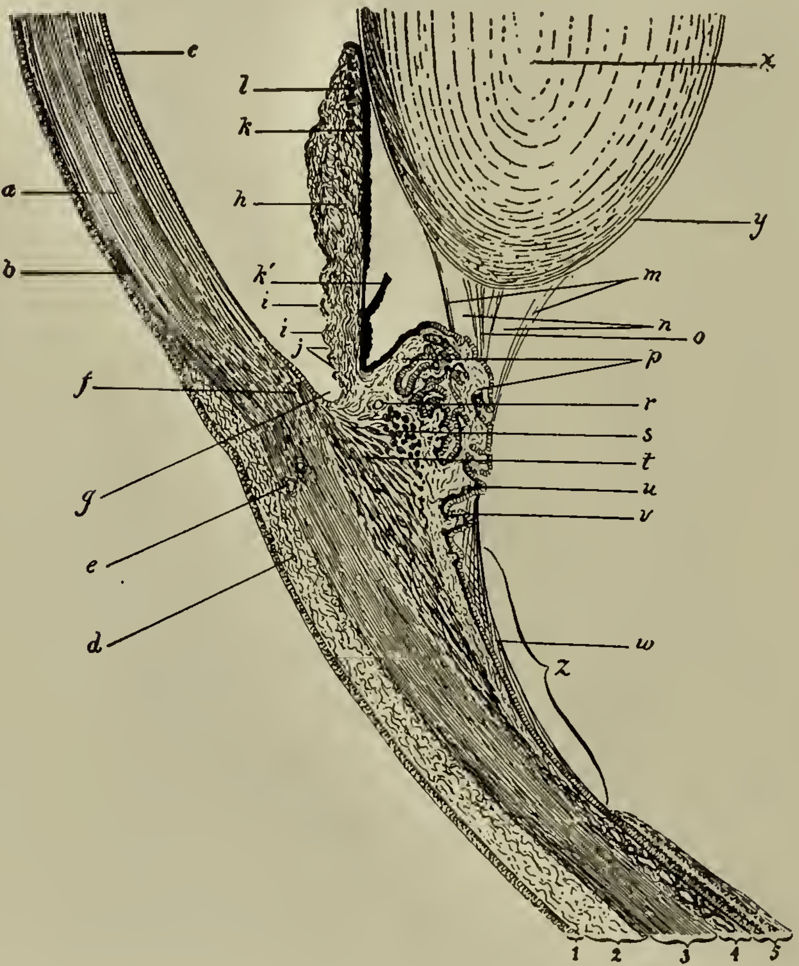
The *entoptoscope* of Barrett makes use of the principle of the pinhole device of Listing in the self-examination of cataract. The patient looks at the sky through a minute opening in the appliance and is able, at his leisure, to study the form and watch the variations of the opacities in his own lens.

This is also a favorite scheme of empirics, who employ it to convince their victims not only of the presence of cataract but to prove to them that the opacities are disappearing under their magical treatment.

The *pictures made by progressive senile cataract,* from the time when the first, faint striæ appear until the cataract is complete, are often very pretty, and remind one of the geometrical shapes seen when snow-flakes are examined with a lens.

The time occupied by the process varies greatly, but may extend over many years; some opacities remain stationary during life.

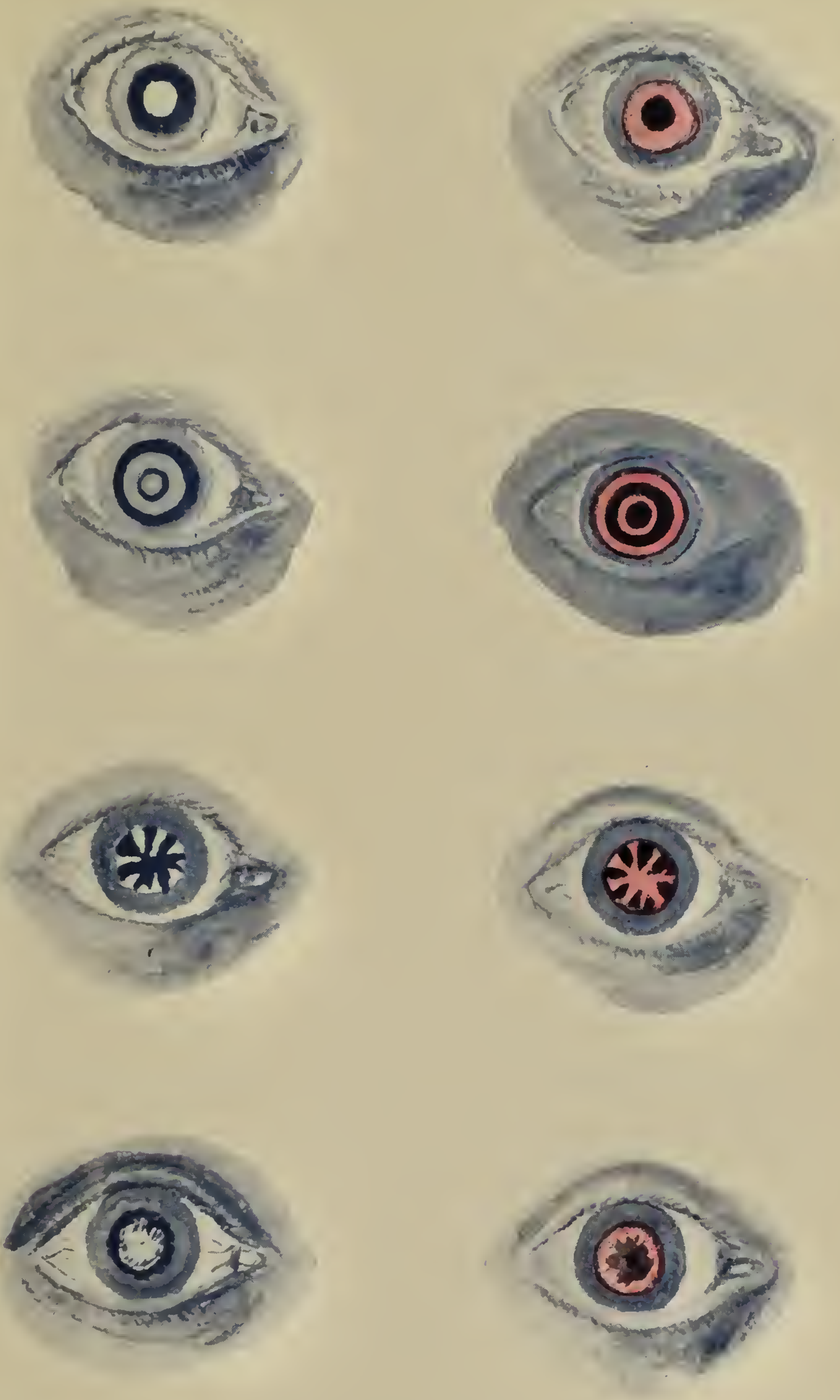
Lattice-like cataract is a name given to several different cataract forms in which the opacities, as seen by the ophthalmoscope, take on the appearance indicated by the name.



The Immediate Relations of the Crystalline Lens System. (After Quain.) a, Cornea; f, Canal of Schlemm; g, Iridic angle; h, Iris; k, Posterior pigment layers (detached); m, c, Zonular fibres; n, Interfibrillar spaces; p, r, s, t, Ciliary body; 1, 2, Conjunctiva; 3, Sclera; 4, Chloroid; s, Retina.

A form of lenticular opacity, probably due to the abstraction of water from all the tissues of the body, including the crystalline, not uncommonly shows itself in the last stage of cholera—a fact that favors Leber's hydration theory of the production of certain forms of cataract.

Fenestrated cataract is a partially opaque lens in the midst of which there is a window-like opening of transparent crystalline substance



Different Forms of Cataract as Shown by the Oblique Illumination (Colburn).

through which vision is more or less preserved. This condition is not uncommonly found in senile cataract (q. v.).

Sight will not be much affected until the nucleus (in the area of the pupil) is involved. The patient then complains that images are distorted or multiplied (polyopia), or that there is a cloud, or floating body, before the eyes. During this period (incipient stage) the sectors or streaks of opacity, when viewed through the dilated pupil, appear grayish by oblique illumination, and black with the reflected light of the ophthalmoscope, the red reflex of the fundus showing through the clear portion of the lens. The fogginess increases very slowly until finally the visual acuity is reduced to the counting of fingers. In the early stages, before the opacity has completely invaded the periphery, vision is better in a dim light, because the moderate dilation of the pupil that occurs in a partially illuminated room, for example, permits the patient to see through some, as yet unaffected, peripheral parts of his lens. Occasionally a person blind in a bright light is able to read if he shades his eyes with his hand.

As the cataract advances the lens swells, becomes more convex, and the patient may be able to discard his reading glasses entirely (although the affected eye always sees worse in the distance), owing to the increased refractive power of the crystalline. He then develops the condition commonly known as "second sight."

Immature cataract. As elsewhere stated this subject might from the practical view-point of treatment be considered as an extension, a continuation of or as a supplement to that of incipient cataract (q. v.), or to include partial and stationary cataracts.

Under what circumstances and under what conditions the surgeon is justified in agitating the patient and his family by telling him he has cataract—that most disturbing of names to the public—is not always easy to determine. The Editor's practice is *generally* to tell the *patient* the exact truth, so far as he knows it, and always to inform the nearest-of-kin when it is thought best to avoid speaking directly to the invalid. An important matter is to inform the patient when a few peripheral-lenticular striæ are the only changes present that "these are to be found in the eyes of most elderly people, that one does not feel like dignifying them by the term 'cataract,' that they may never interfere with vision, that one 'should not cross bridges' until they are reached, and that the only reason for mentioning them at all is that if seen later by another surgeon the patient may know that they were discovered previously and were not then regarded as serious."

The attempt to *remove the opacities of unripe senile cataract*, or at least to stay the progress of the opacification in the early stages of the disease, has been made from the earliest times by the employment of every possible remedy, local and general, medical and surgical, simple and operative. This subject is discussed under **Cataract** and under the heading **Cataract, Incipient**, so that it will be sufficient to say here that the only form of lenticular opacity that holds out any prospect of relief by any method is that which results from a removable cause—as in senile diabetes, or certain traumatic opacities, as in the cataract of Vossius, etc.

More of historical than of practical interest are the efforts of early surgeons to cure cataract by operative procedures other than extraction. Soelberg Wells mentions that of Sperino (Turin, 1862) by repeated *tapping of the anterior chamber.* He says: "This mode of treatment is chiefly based upon the theory that the impairment of vision in cataract is partly dependent upon a temporary disturbance in the intraocular circulation, especially an occasional state of congestion of the choroid, and partly upon the opacity of the lens. Sperino holds that the opaque lens fibres may regain their transparency as long as their intimate structure is not disorganized, which always follows, more or less rapidly, upon the opacity, but less so in old than in young persons. Now, as the operation of tapping the anterior chamber relieves the intraocular circulation, it often produces a marked and immediate improvement in the sight, and in some cases often-repeated tappings have at last effected a complete cure. In others their effect has been but moderate, or even negative. The operation consists in making a small puncture with a broad needle at the edge of the cornea or slightly in the sclerotic; a blunt probe is then inserted between the lips of the wound, and the aqueous humor slowly evacuated. The evacuations by the same opening may be made repeatedly during a single sitting, followed by an interval of several days, or singly at an interval of a day or two. The operations in cataract were repeated a great number of times. In one case 167 tappings were made, and finally linear extraction was performed."

On the other hand, Henry Smith (*Lancet*, Apr. 20, 1912) believes that, in certain cases, subconjunctival injections of mercuric cyanide (from 1:5000 to 1:2000) every two days to a week have a decided value in clearing up early opacities. The treatment should be continued for a month; if no improvement occurs in that time it ought to be discontinued. One per cent. acoin should always be combined with the injections; otherwise the pain is too severe to be borne. In my experience of these injections a weak dose, 1:5000 to 1:10000 should be administered at the commencement of the treatment to test the effect of the remedy and to estimate the reaction it produces in individuals.

In cases of senile cataract of slow development, in which for any reason a preliminary iridectomy cannot be done, Neves Da Rocha (*Anales de Oftalmologia*, February, 1913), dilates the pupil for optical purposes with euphthalmin, in three to five per cent. solution or as salve, and has never experienced any inconvenience from its use. The intraocular tension and accommodation are not affected, and no toxic effects are produced. Pupillary dilatation begins after use of the three per cent. solution twenty minutes after instillation and lasts about four hours: about six hours after the five per cent. mixture. Yellow glasses are ordered to avoid dazzling. This observer considers the remote danger of increased tension during the night; hence he advises that the drug should not be used after six o'clock in the evening.

Regarding the *maturation of unripe cataract,* it may be said here that this procedure is to be considered in persons under sixty-five years of age when the patient has sunk so low that he is unable to pursue his usual avocation; after sixty-five the lens is generally so sclerotic that artificial ripening is not necessary. However, in all extractions of unripe cataracts, that one may be able to see all the otherwise transparent, immature lens matter, it is advisable to perform a preparatory iridectomy and capsulotomy. The Homer Smith operation seems admirably adapted to this contingency.

The *maturation* of unripe cataract has been discussed elsewhere under **Cataract, Unripe**, and in Vol. I, p. 635, of this *Encyclopedia.*

We are occasionally called upon to deal with cataract in persons more than 50 years of age who have had, until recently, some form of hitherto stationary opacity—often congenital—but in which the surrounding fibres have become, for one reason or another, cataractous. In the majority of these cases, doubtless, the pre-existing degeneration has predisposed to further formation of opacity of senile character. These cataracts may show the presence of cholesterine (or allied deposits) in the lens substance. Kuhne and Jacobson have demonstrated that cholesterine exists normally in the lens—especially in senile lenses. As it is in solution it is not visible, but in pathological states it is deposited as crystals and then presents an appearance like the *synchesis scintillans* of the vitreous body.

The first cases of *cholesterine cataract* were described by Lang, in a man 60 years of age, with failing vision for 10 years. He found unripe nuclear cataracts, with vision of 6/24, and cholesterine crystals plentifully scattered about the centres of the lenses. The fundi were normal. Lang thought the deposits resembled, *in situ,* tyrosin but when the lenses were later extracted the crystals proved to be cholesterine. Marcus Gunn about the same time described a cataract of the coralliform type beset with cholesterine crystals, while Hirschberg, Hess and others have reported analogous cases. Baas described a case of crystalline concretions in the lens thought to be *leucine,* while Axenfeld describes another, like "shot silk," which he thought might be colloid deposits, like *"Drusen."*

When the cataract is ripe or mature the whole lens is opaque, and it can safely be removed from the capsule by operation without leaving any soft, lens-matter behind. Such a cataract should have a mother-of-pearl appearance by oblique illumination, and while the examination is being made (pupil undilated) the iris should not cast a shadow on the lens surface. Shadows cast by the iris on the lens indicate that the anterior layers of the crystalline are still immature and transparent; the shadow being thrown on the opaque nucleus. There should also be no glittering sectors or facets brought to view as the patient is told to look in different directions during the examination.

When an operation is undertaken on an immature cataract the soft, glue-like portions of the unripe lens stick to the parts in the anterior chamber, and resist ordinary attempts at removal. These small masses not only act as foreign bodies, producing irritation and inflammation of the iris, but transparent at first, finally become opaque, and lower the visual acuity.

In time the cataract becomes hypermature, or over-ripe. It may then shrink, or, becoming soft, semi-fluid, or of milky consistency, allow the hard nucleus to sink to the bottom of the capsule cavity, showing there as a small, amber-colored body, or Morgagnian cataract (q. v.). In such cases the iris loses its natural support, and an iridodonesis is the result. Sometimes the opaque lens takes on a dark-brown color, and with oblique illumination the pupil presents a black, almost normal appearance, although the cataract is mature (black cataract).

Cataract may remain stationary and unless the opacity involves the central portion of the lens, vision may be very little impaired. Even when the opacity involves the pupillary area, it may take several years for the cataract to mature, and become favorable for removal.

Risley believes that the term senile, "which still occurs in our catalogs as a qualifying adjective, has been misleading, since it removes hard cataract, in the mind of the student, from the domain of pathology, and places it, like gray hair, etc., among the signs and concomitants of advanced life; whereas opacity of the crystalline lens occurs at any age. It is soft when present in early life, partly for the reason that in infancy and youth the normal lens is relatively soft, it is hard in old age, because even the transparent lens in advanced life is relatively hard. In the hard cataracts of middle and advanced life we should also regard them as the result of antecedent pathologic states of the fundus oculi. Such a view would not only modify our prognosis in many cases, but change our procedure in many important respects. For example, if asthenopic symptoms are still present, we would not hasten our operative procedure, not because of immaturity of the cataract, but for the reason that the choroid behind the opaque lens is still in a pathologic state, the judicious treatment of which for a few weeks or months would materially improve the prognosis as to a favorable result from extraction. It is probable that in this view of the nature and cause of the opaque lens we find a sufficient explanation for the proverbially bad results following attempts at extraction of immature hard cataracts after 55 years or 60 years of age; or, on the other hand, for the more favorable prognosis entertained in cases of fully 'ripe' lenses."

The *percentage of senile cataract* to the total number of diseases of the eye and lens has been pretty generally calculated for this country and abroad. Becker, in 1877, and de Wecker, in 1886, published several tables from which it was concluded that of 100 cases of ocular disease the crystalline was involved in 4.9 per cent., of which 4.5 per cent. were cataracts and 3.2 per cent. senile opacities. The following clinics were included in these figures:

	Diseases of the Lens.	Senile Cataract.
Arlt, of Vienna	7.30	5.10
Becker, of Heidelberg	6.00	3.70
Knapp, of Heidelberg	7.60	5.70
Knapp, of New York	5.50	2.80
Pagenstecher, of Wiesbaden	9.30	6.30
Steffan, of Frankfort	4.20	3.00
De Wecker, of Paris	16.50	14.40
Horner, of Zurich	7.20	3.60

Dor (*Encyclopédie française d 'Ophtal.* VII, p. 276) has collated the figures from Nagel's *Jahresbericht,* 1877 to date of publication, with the following results:

	No. of Patients.	Diseases of the Lens.	Per cent.
Germany—			
Berlin (1902)	25,509	1,794	7.03
Breslau (1880)	5,823	264	4.50
Breslau (1890)	8,011	223	2.70

Frankfort (1880)	6,854	256	3.70
Frankfort (1890)	7,453	246	3.30
Giessen (1890 to 1906)	14,805	705	4.76
Greifswald (1880)	1,892	159	8.40
Greifswald (1890)	1,672	107	6.40
Greifswald (1902)	3,657	340	9.20
Leipzig (1882 to 1902)	147,418	4,583	3.10
Munich (1880)	8,176	953	11.60
Munich (1890)	8,802	727	8.10
Posen (1880)	2,312	120	5.20
Stuttgart (1880)	2,884	135	4.60
Stuttgart (1890)	3,187	136	4.20
Tübingen (1876-1900)	56,806	3,966	6.90
Wiesbaden (1902)	2,871	260	9.40
Würzburg (1880)	3,304	258	7.80
Würzburg (1890)	6,277	439	7.00
All the policlinics (consultations gratis) of Prussia	45,629	2,425	5.90
Austria—			
Vienna	8,451	618	7.30
Salzburg	2,788	342	12.30
Laibach	7,367	695	9.10
Belgium	17,791	757	4.20
France—			
Paris	40,000	4,839	12.09
Lyon	18,594	1,668	8.90
Holland—Utrecht	2,065	154	7.40
Russia—			
Petersburg	40,835	2,504	6.10
Odessa (1880)	3,882	235	6.05
Odessa (1890)	4,134	310	7.40
Switzerland—			
Basel (1880)	1,741	86	4.90
Berne (1867-1876)	4,620	314	6.80
Berne (1880)	2,329	115	4.90
Lausanne	2,669	213	7.30
Turkey—Constantinople	11,050	432	3.90
United States of America—			
New York (1880)	4,324	241	5.50
New York (1890)	6,052	226	3.70
New York (1902)	9,424	321	3.40
Boston (1880)	7,212	257	3.50
General total for a single year	143,051	8,674	6.15

The foregoing tables show that the percentage of cataract varies considerably in different parts of the world; further investigation shows that it appears to be variable in the same clinic at different seasons of the year and for different years. The distribution of cataract throughout the world is as yet incompletely studied but will be considered, later, under **Geography of ocular affections.**

Etiology of senile cataract. Not only has asthenopia of various kinds and degrees been attributed to *phosphaturia,* but it has been accused of producing morbid changes in the lens—*phosphaturic cataract.* Teissier, of Lyons, detected in twenty patients suffering from phosphaturia three with cataract. H. Dor investigated this subject in 1877 and found that the normal amount of phosphates excreted in normal urine is about 2.50 grams per litre; 3.75 grams during the 24 hours. During observations extending over two years he found seven cataractous patients whose lenticular opacities could only be attributed to their phosphaturia.

Gerok has given us figures that seem to prove the so-called senile cataract to be *not due to age alone.* He agrees with Dor that it is always a disease and not a senile degeneration or an evolutionary product—like grey hair. Gerok's table is as follows:

Congenital, 5.8 per cent.; 0 to 10 years, 0.7 per cent.; 10 to 20 years, 1 per cent.; 30 years, 1.8 per cent.; 40 years, 3.3 per cent.; 50 years, 8 per cent.; 60 years, 27 per cent.; 70 years, 37 per cent.; 80 years, 17 per cent.; 90 years, 1.7 per cent.

As will be noticed after eighty years the per cent. of cataract actually decreases.

The *non-operative treatment* of lenticular opacities as well as their disappearance without treatment have been discussed under **Cataract** in general and **Cataract, Incipient.** It may be added here that among numerous other methods of treatment *massage* in its various forms, as a means of bringing about a clearing of lenticular opacities, has been urged in view of the experience of Ewald, given under the caption **Ewald's cataract.** Greeff (*Lehrbuch der Path. Anatomie,* p. 539) refers to the fact that certain post-mortem opacities of the lens clear up after pressure on the eyeball, or following blows on the head. These cataractous appearances show themselves in from ten to twelve hours after death, if evaporation from the ocular region is not prevented. If a pointed instrument is passed through the cornea and the anterior capsule is pressed upon the opacity disappears.

This phenomenon is explained by the increase of the proportion of salt in the aqueous by the loss of water through evaporation. The opacity consists of fine droplets of albuminoids. On mechanical pressure the lens substance is supplied with fluid which has probably collected beneath the capsule. In this way the irregular albumin deposits are uniformly arranged so that the refractive index is the same throughout the lens mass.

Although one rarely encounters a case of absorption of cataract, especially of nuclear absorption, *in a patient more than forty years of age* (and it would be unwise to expect it in any particular patient), yet instances of the disappearance by solution of senile cataract have been reported from time to time. One of the latest of these reports is by W. H. Dudley (*Ophthalmology,* July, 1913, p. 492), as follows: J. B., aged sixty-six, while using a miner's pick for the purpose of cleaning out the floor of the tunnel struck a piece of "giant" powder which exploded before his face. His left eye suffered most, there being several pieces of quartz, varying in size, imbedded in the cornea, some of which were quite deep, two of which produced abscesses. Careful examination did not reveal any sign of complete penetration of the cornea by the quartz, though the cornea was much infiltrated, so that this question could not be satisfactorily determined. By this time a rather active iritis existed, and after dilating the pupil, the lens was found to be cataractous throughout, and swollen, with quite narrow anterior chamber. The tension was normal as taken by the fingers, the projection good, and but very little pain. The eye was quite red but not chemotic. As much as possible of the quartz was removed from the cornea, atropine instilled, and eye watched. About a month later the reaction was much less, tension increased at no time; but now a small flake of lens matter appeared in the anterior chamber. About three weeks later the lids became edematous without any known cause, which however subsided in a few days. Lens matter was observed in the anterior chamber much of the time for six months, when the patient noticed a little vision in this eye, and the ophthalmoscope showed a red reflex through a small opening in the middle of the lens.

Two weeks later the tunnel through the lens was 4-5 mm. in diameter, and four months later through a wide pupil no sign of lens matter could be seen. The fundus was normal, and with proper lens he could see 20/40, and could read Jaeger No. 1 without much hesitation.

OPERATIONS ON SENILE CATARACT.

The extraction of the senile type of cataract is probably the most important operation the ophthalmic surgeon is called upon to do, and while in the average case the result is satisfactory yet that task, surrounded by many difficulties and chances of disaster, should never be lightly undertaken. It is at least due to the patient that the operator—especially the practitioner with slight experience—should carefully review before each operation the technique and have an organic knowledge of the usual accidents and other complications that may precede, accompany or follow the attempt to remove this obstruction to vision.

While it is chiefly by practice on the living human subject that one becomes most expert in the delicate manipulations that constitute a deftly performed extraction, yet a great deal may be learned from a carefully worded description of it. In the following pages it is intended to carry the student along, *pari passu,* by considering not only the manipulations and instrumentations in their regular order but to set down—at the time and place they generally occur—those deviations from the straight path of normal cataract extraction that every well-informed operator should bear in mind.

It is not to be supposed that it will ever be possible for ophthalmic surgeons to agree upon a universal method of lenticular extraction; indeed, there is a constant tendency to vary not only every step of the original operation but every step of the operations now performed by the best known surgeons. The earnest ophthalmologist eagerly embraces every chance to perfect his own technique, as well as to increase the value of the operation in the hands of others. Yet the personal equation that, sensibly or insensibly, governs the choice of methods in other departments of human endeavor will continue to dominate the selection of ways and means in cataract removal. If we have the chance of comparison we generally choose those instruments and adopt those methods that appear to suit best our peculiar manipulative skill — or lack of it. Moreover, the surgeon who has mechanical ability is very likely to make, in one or more existing instruments or methods, such modifications as appear to him (and may or may not appear to his fellows) to be improvements.

Shall we operate on a mature cataract, the other eye being normal? Ever since the days of the early ophthalmic surgeons when Maître-Jean and Saint-Yves recommended the operation, and Richter and Lawrence advised against it, authorities have divided on this question. The advantages of a wider field of vision—not of *binocular fixation* for that is not possible (as experience has shown) when there is a refractive difference of six diopters or more between the aphakic and the normal eye—and the ability to distinguish large objects approaching on the aphakic side of the patient are not to be despised in this country of crowded streets, level railway crossings and reckless automobile driving, yet the diplopia, confusion and asthenopia that not infrequently follow the single operation should make one pause before attempting it.

J. Herbert Parsons (*The Lancet,* November 9, 1912) considers the advantages which may be expected to accrue to the patient from successful operation in such cases are (1) restoration of the full field of vision, which may be a matter of great importance, especially to working people, and which will diminish the risks incurred when working in the midst of machinery or moving about in crowded thoroughfares. 2. The restoration of central vision is less of a gain than the improvement of the field; the high degree of anisometropia prevents the patient from using the eyes together; this fact depends partly upon the difference in size of the retinal images in the two eyes, a difference so great that the images cannot be fused, but probably to a still greater degree upon the unequal prismatic effects of the correcting lenses when they are looked through obliquely, as occurs when the eyes roam from side to side. 3. The cosmetic effect will naturally be assessed at a different value by different individuals; the cataractous pupil is often a matter of great discomfort and annoyance to the patient, interfering with his happiness and sometimes preventing him from obtaining employment.

Regarding unilateral senile cataracts, the general considerations already detailed leads Parsons to avoid operation in these cases unless the field of vision is of prime importance to the patient, or the appearance of the eye prevents the patient from earning his living. There is, however, one potent indication for operation, and that is the appearance of signs of hypermaturity; the thickening of the capsule which attends the process and other changes occurring in the lens substance add so much to the dangers and difficulties of extraction that they justify early interference. When undertaken for cosmetic purposes iridectomy must be avoided if possible, a fact which most surgeons will regard as an additional contra-indication to be given its due weight.

At any rate, the "pros and cons" of the situation should be laid before the patient and he be allowed to make the choice. Of course, if the sight of the second eye be involved, or if the vision in it is not good, or if the cataract is becoming hypermature, or if a *cosmetic* result is regarded as of prime importance, the argument for the extraction of the cataract is all the stronger. As a rule, the patient is better satisfied if no correction is worn before the eye operated on.

Glaucoma occurring in either forming or mature cataract should be treated before the extraction of the lens. Salus (*Klin. Monatsbl. f. Augenheilk.,* Vol. 48, August) discusses this question in connection with five cases of glaucoma arising in the intumescent stage of senile cataract.

He also calls attention to the fact of the frequent occurrence of lenticular opacities in stokers and glass-blowers, previously noted by Bayers, and thinks that those compelled to work in the immediate neighborhood of powerful heat are necessarily more susceptible to rapid swelling of the lens, and the observations of Hirschberg on the prevalence of cataract in tropical countries seem to lend support to this view. Salus thinks that if by means of instillation of miotics the tension can be reduced to normal, and the anterior chamber is sufficiently deep, immediate extraction is indicated, if the glaucoma has existed only a short while. Should the anterior chamber remain shallow, and the tension abnormally increased, a posterior scleral puncture followed by an extraction is to be performed.

Most surgeons have agreed that an *extraction operation should not be done at one sitting on two eyes affected by bilateral cataract,* the risk being too great, but a second operation may follow the first as soon as the operative wound has healed, say, in two or three weeks. This matter was fully discussed in all its phases by Calhoun (*Trans. Ophthalmic Section, A. M. A.,* June, 1904) and to this admirable paper the reader is referred.

Historical review of cataract extraction. The palm for the discovery of the extraction of cataract through an opening in the eyeball is very properly awarded to Daviel. That surgeon had, however, a number of forerunners.

Both Antyllus and Galen, as well as surgeons of the Arabian school of ophthalmology, speak of the operation upon so-called cataract through an opening into the anterior chamber, but there can be no doubt that this had reference to the drainage of hypopyon—the so-called fluid hypochymata.

Maitre-Jean and Brisseau in the beginning of the eighteenth century for the first time correctly interpreted the conditions underlying ordinary cataract. These discoveries were further elaborated by H. Freytag and Blancard.

Freytag describes the operation which he performed several times, but always on dislocated lenses, during 1692 to 1698. He made a very small opening in the cornea with a knife-needle and endeavored to withdraw the cataract through the perforation by means of a hook.

Blancard did not actually do an extraction but described an operation which he believed might be done.

St. Yves was probably the first to make a sufficiently large opening in the cornea and through it extract the lens, but this operation, again, was done on a cataract dislocated into the anterior chamber. During the year 1707 he extracted two such lenses in the presence and under the direction of Méry. In exactly the same way Pourfour du Petit, in 1708, also on the advice of Méry, removed a lens dislocated into the anterior chamber.

In 1745 Daviel, while endeavoring to perform an operation such as Petit had done some years before upon a portion of a cataract that had found its way into the anterior chamber, having made the first part of the Petit operation, enlarged the opening with scissors and removed the whole body of the lens by means of a spatula, which he introduced through the pupil and with it brought the lens into the anterior chamber and then out of the eye. This operation, performed upon a woman, was followed by good visual results. Then followed four other cases in which the lens was successfully removed entire in its capsule. After that experience he had a number of cases that did not turn out so well—a result which he thought due to defects in his technique; he failed to incise the capsule sufficiently or to make the opening in the cornea sufficiently large. In the year 1750, however, he decided to remove all cataracts by this method. There can be no doubt, therefore, that to Daviel belongs the honor of the discovery and invention of the modern method of cataract extraction. It may further be stated that we have not in any essential degree improved upon the original method. It is true that we have added to it those inestimable boons, local anesthesia, asepsis and antisepsis, but the technique of the favorite form of extraction has not essentially changed in 150 years.

When Daviel, on the 13th of April, 1752, published his first celebrated communication to the Académie Royale, he had already performed 200 operations. He made an opening first into the anterior chamber at the lower margin of the cornea, using for the purpose a sharp-pointed, lance-like knife very much like our ordinary keratome. This opening was then enlarged on both sides with a blunt-pointed, double-edged knife and, when necessary, the incision was further continued with delicate scissors so curved on the flat as to follow the sclero-corneal circle. The whole incision corresponded to the limbus and involved about one-half the corneal circumference. These scissors were made both right and left, the blade introduced into the anterior chamber being blunt-pointed. The corneal flap was, after completion of the incision, gently raised with a small spatula (still known as Daviel's spoon) and the lens incised with a sharp needle.

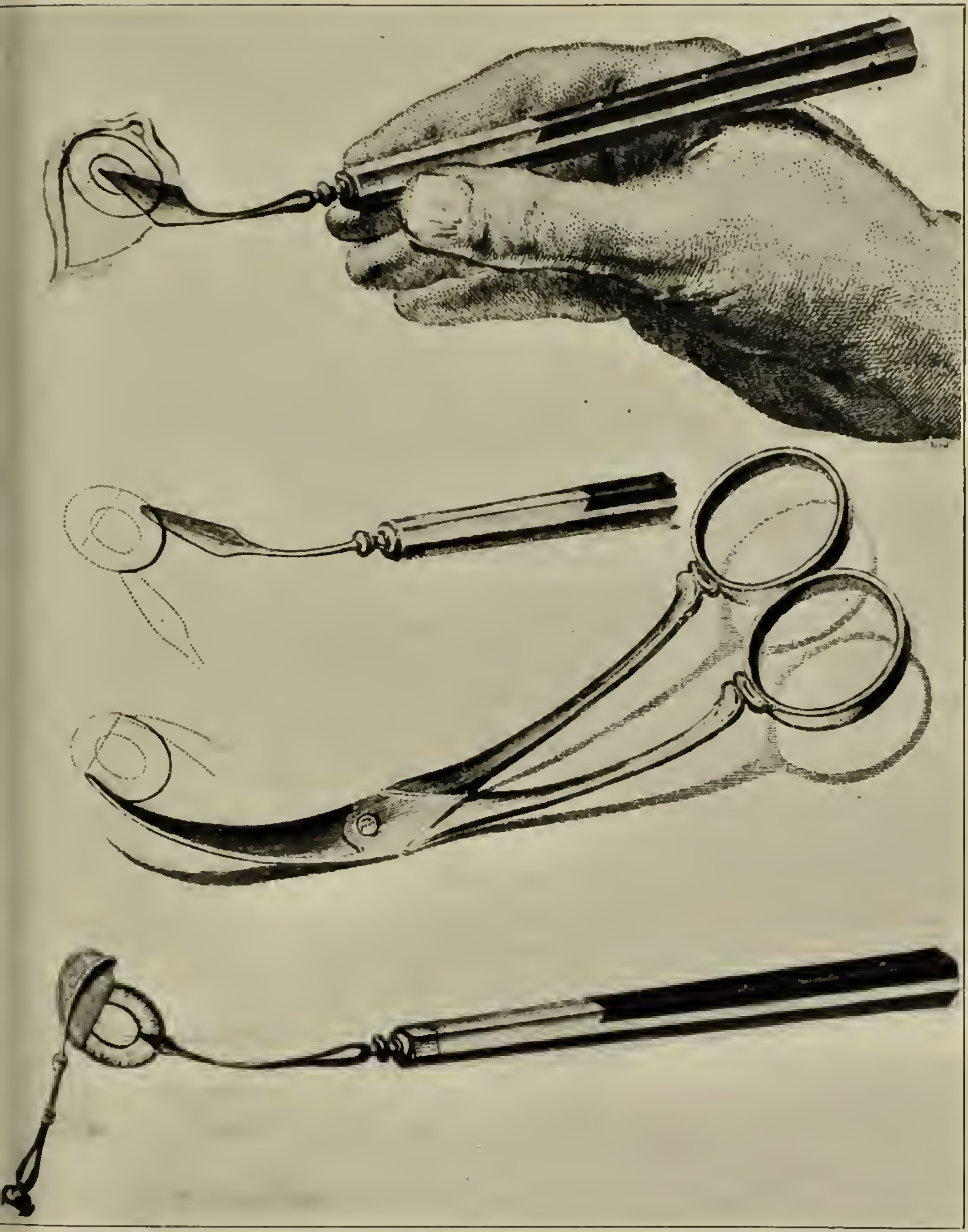


Fig. 10.

Reproduction of Daviel's Sketch, Showing the Instruments Employed by Him in Making His First Cataract Extraction.

Daviel's method of cataract extraction, showing the technique of the corneal incision first with the *aiguille pointue* or keratome, the enlargement of the opening with the blunt pointed knife, the completion of the operative wound with the scissors, the opening of the capsule and the final extrusion of the lens.

The delivery of the lens followed by means of pressure upon the lower margin of the wound with the first and second finger-tips placed upon the lower lid. When the anterior capsule was found to be thickened a complete disc was cut out of it and removed from the interior of the eye. The flap was then allowed to fall into place. It is quite easy to follow the various steps of the Daviel operation from the illustrations that appear with his original paper.

In spite of this great improvement in dealing with cataract extraction the old operation of couching or reclination died hard. Pott, in England, and Scarpa, in Italy, not to mention Buchhorn, Lengenbeck, Dupuytren and others, continued to do the latter operation in preference, but eventually Sharp, Wenzel, Wathen, Warner, Tenon, Pamard, Richter, Thos. Young, Beer and others, who had taken up the cudgels for the new procedure, made it the established method of extraction.

Then the technique of cataract extraction was further improved by the introduction of artificial mydriasis, first employed for that purpose by Himly.

In 1753 Samuel Sharp, in endeavoring to improve upon the method of Daviel, made use of a knife in cataract extraction which (see the figure) was straight on its flat surface but somewhat convex on its back. It was slightly concave on its edge, little less than an inch long and at its heel about one-eighth to one-sixteenth of an inch wide, gradually tapering to a fine point. According to Hubbell, Sharp first used his knives on April 7, 1753, but before June 11, 1753, when de la Faye first employed his on the living subject, he had made seven extractions with it. Previous to Sharp's first operation no other surgeon had used a single knife in making the corneal section. We may, therefore, accord to Sharp the honor of first using a knife alone.

From Sharp's first paper we take the following description of his operation:

"Place the patient in the same situation as for couching, either opening the eyelids with your forefinger and thumb, or letting an assistant raise the upper eyelid, whilst you yourself keep down the under eyelid. Then, with a small knife (see the figure), holding its edge downwards, make a puncture through the cornea near its circumference into the anterior chamber of the eye, in such a direction as to carry it horizontally, and opposite to the transverse diameter of the pupil, after which you are to pass it towards the nose, through the cornea from within outwards, as near to its circumference as in the first puncture.

"When you have made the second puncture, push the extremity of the blade one-seventh of an inch beyond the surface of the cornea, and immediately cut the cornea downwards, drawing the knife towards you as you make the incision. After this, you press gently with your thumb against the inferior part of the globe of the eye, in order to expel the cataract (in its unruptured capsule) and the operation finishes, according to the different circumstances, as in the manner proposed by Mons. Daviel.

"One extraordinary benefit seems to arise from the use of this single instrument, and perhaps from the shape of its blade, which increases in breadth all the way towards the handle; for, by this means, the punctures are so exactly filled up by the blade that very little of the aqueous humor is discharged before you begin to make the incision, and consequently during this time the cornea preserves its convexity; whereas by using one instrument to puncture, and others to dilate, the cornea immediately becomes flaccid, upon the issue of the aqueous humor, and renders the operation tedious and embarrassing, as I myself have found by experience in one patient, on whom I performed the incision of the cornea with a pair of scissors, as recommended by Mons. Daviel."

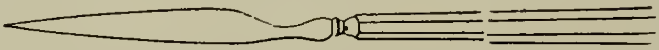
From this time henceforward the single knife, modified in different ways by Poyet, of Paris (1753), Joseph Warner of London (1754), Louis Béranger, of Bordeaux (1756), Jacques Réné Tenon, of Paris (1757), Pierre-François-Benezet Pamard, of Avignon (1759), and by others in rapid succession, soon became a powerful rival of Daviel's knives and scissors, and finally, long before the end of the 18th century, it superseded them entirely.

Sharp not only exhibited and demonstrated his instrument in England but, during the summer of 1753, sent one to his friend Morand, at that time Secretary of the Académie Royale de Chirurgie, who showed it to Parisian surgeons and inserted a cut of it (together with the proposed knife of de la Faye) in the *Mémoires*.

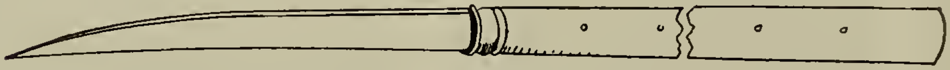
The complications following the Daviel operation were probably the main reason for the abandonment of several instruments (in making the corneal incision) for the use of the single knife.

Cataract knife (Young.). We are indebted to A. A. Hubbell for a description of the knife used by Thomas Young. As will be seen in the accompanying figure, it had a blade 4 cm. (about one-and-a-half inches) long, 5mm. (about two-and-a-half lines) wide at the heel, whence it tapered by gentle convexity of the back and edge to a very sharp point. It was straight on its flat and the back was blunt. It was mounted in a suitable handle by means of a constricted shank half-an-inch (12 mm.) long. Young's knife seems to have been overlooked by his contemporaries although it is referred to both by Ens and by Sprengel.

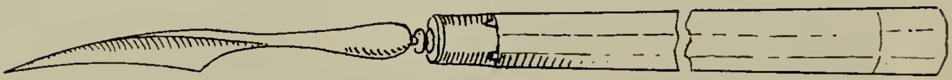
After de la Faye came Béranger, who employed a knife in making the corneal opening of a shape that forecasted the instrument of Beer and Richter. The illustration of Béranger's knife and its use is furnished by de Wecker's well known work. Soon there were many more cataract knives. Every new operator seemed to consider it his duty to modify or "improve" some of the instruments employed in the operation, so that in the year 1821 Lachmann reports 69 different knife models!



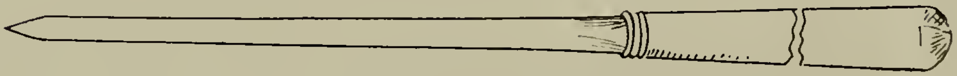
Thos. Young's Cataract Knife.



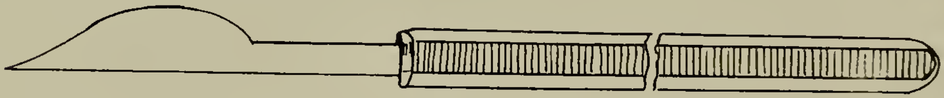
Knife of De La Fay (1753.)



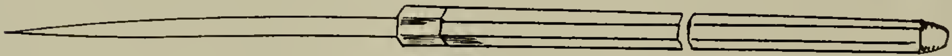
Knife of Sharp (1753.)



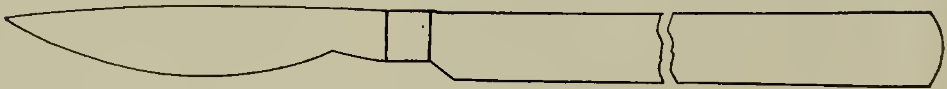
Knife of Poyet (1753.)



Knife of Beranger (1756.)



Knife of Tenon (1757.)



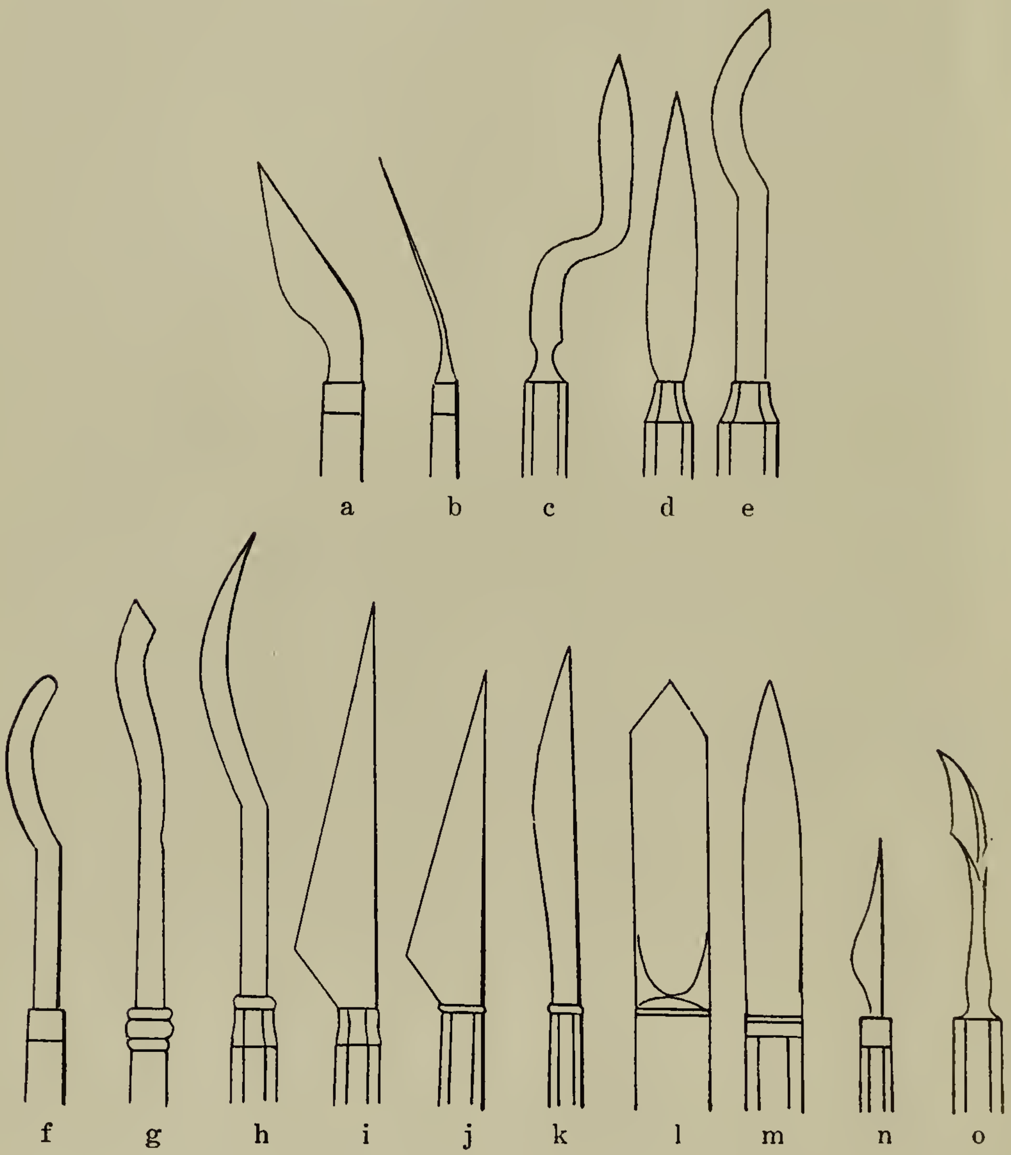
Knife of Pamard (1759.)

First Knives Used in Cataract Extraction. (Hubbell.)

We must not forget an early operation for complicated cataract, viz. —that of Wenzel, whose knife is shown in the next illustration. Knapp (Norris and Oliver's *System*, Vol. 3, p. 810) speaks of it as *extraction with simultaneous corneal and iris flaps* intended for cases of total posterior synechia,—*i. e.*, adhesion of the whole posterior surface of the iris to the anterior capsule. "It is a matter of frequent experience that in such cases an iridectomy will remove only the anterior layers of the iris, but leave the dense and dark uvea unbroken upon the capsule. Wenzel thrust his cataract-knife, as soon as it had pierced the cornea, also into the adjacent part of the iris, pushed it straight forward through the lens, pierced the iris and cornea on the nasal side, and completed the section as in an ordinary flap extraction, thus forming a corneal and an iris-capsule flap. Of the latter he excised as much as he could, and then extracted the lens. It is an operation applied to desperate cases, where even a moderate visual result would be a surgical triumph."

It was A. von Graefe who first introduced the so-called linear extraction. It must, however, be remembered that the incision itself was not original with that celebrated operator, because this was precisely the method of opening the anterior chamber adopted by St. Yves (1707), and Petit (1708), when they extracted the dislocated lens from the anterior chamber. It must also be borne in mind that Pallucci first removed the remains of a secondary cataract from behind the pupil through the corneal incision of this variety. In 1795, also, Santerelli made use of an instrument by means of which he opened the anterior chamber at the upper sclero-corneal junction for the purpose of cataract extraction. Gibson in the year 1811 removed soft cataracts, as well as thickened capsule, through a linear corneal wound, but has not left us a very definite description of the operation. F. Jaeger did, in 1813, what is known as the "partial" extraction. Later on Travers first produced a dislocation of the lens into the anterior chamber and then removed it (broken into small masses) through a small linear wound in the cornea. He made a larger opening than Gibson. Bowman and Critchett enlarged the incision, made a small corneal flap and extracted the lens with scoops. Among others Jacobson recognized the fact that incisions within the scleral tissue heal sooner and are less likely to suppurate than when placed entirely in the clear cornea. He revived the lower semi-circular cut but, to avoid prolapse, was obliged to combine with it an iridectomy.

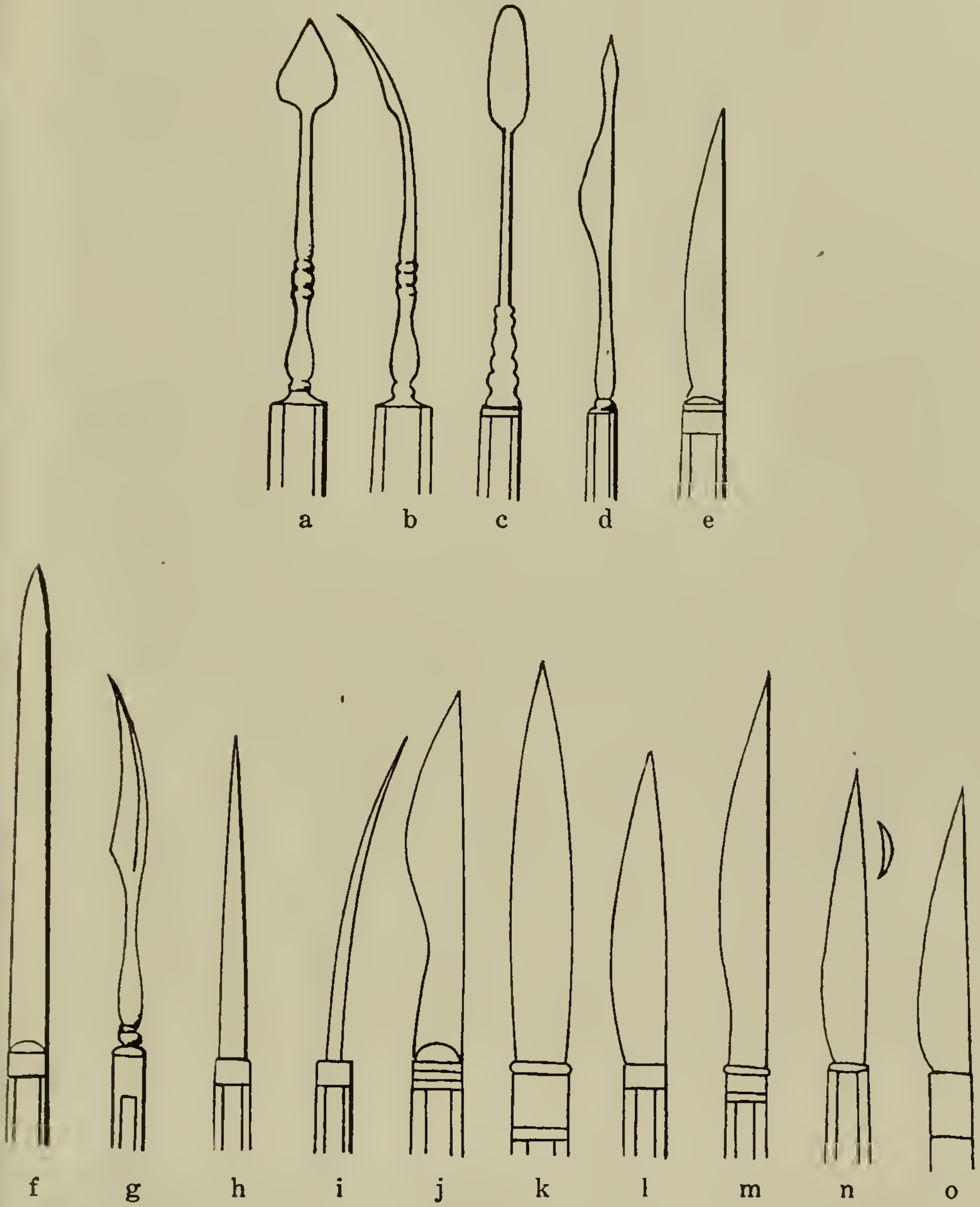
The purpose of von Graefe's earlier incision (1865) was similar to that of Jacobson's—avoidance of infection—and was a combination of a linear wound and a scleral position. As this incision could not be properly made with the keratome-form of knife (Lanze) in vogue at the time he invented his well known knife modelled—as he himself says—after the iris knife of Waldau and Fröbelius. de Wecker suggests than von Graefe appropriated and slightly altered the shape of the de la Faye-Tenon knife for his purpose, but a comparison of the



a and b, Demours; c, B. Bell; d, Wenzel; e and f, Pellier de Quensy; g and h, Pellier de Nancy; i, Barth; j, Beer; k, Santa Anna, l, Santeretti; m, Phipps; n, Mayer; o, Boyer.

Models of Cataract Knives Prior to 1822. (After Lachmann.)

two instruments and the well known probity of the German surgeon, preclude our harboring such suspicion for an instant. It is likely that Graefe did not know of Tenon's work, else he would certainly have mentioned his name in connection with the new instrument. In any event, it was an original application of a modified instrument, already in existence.

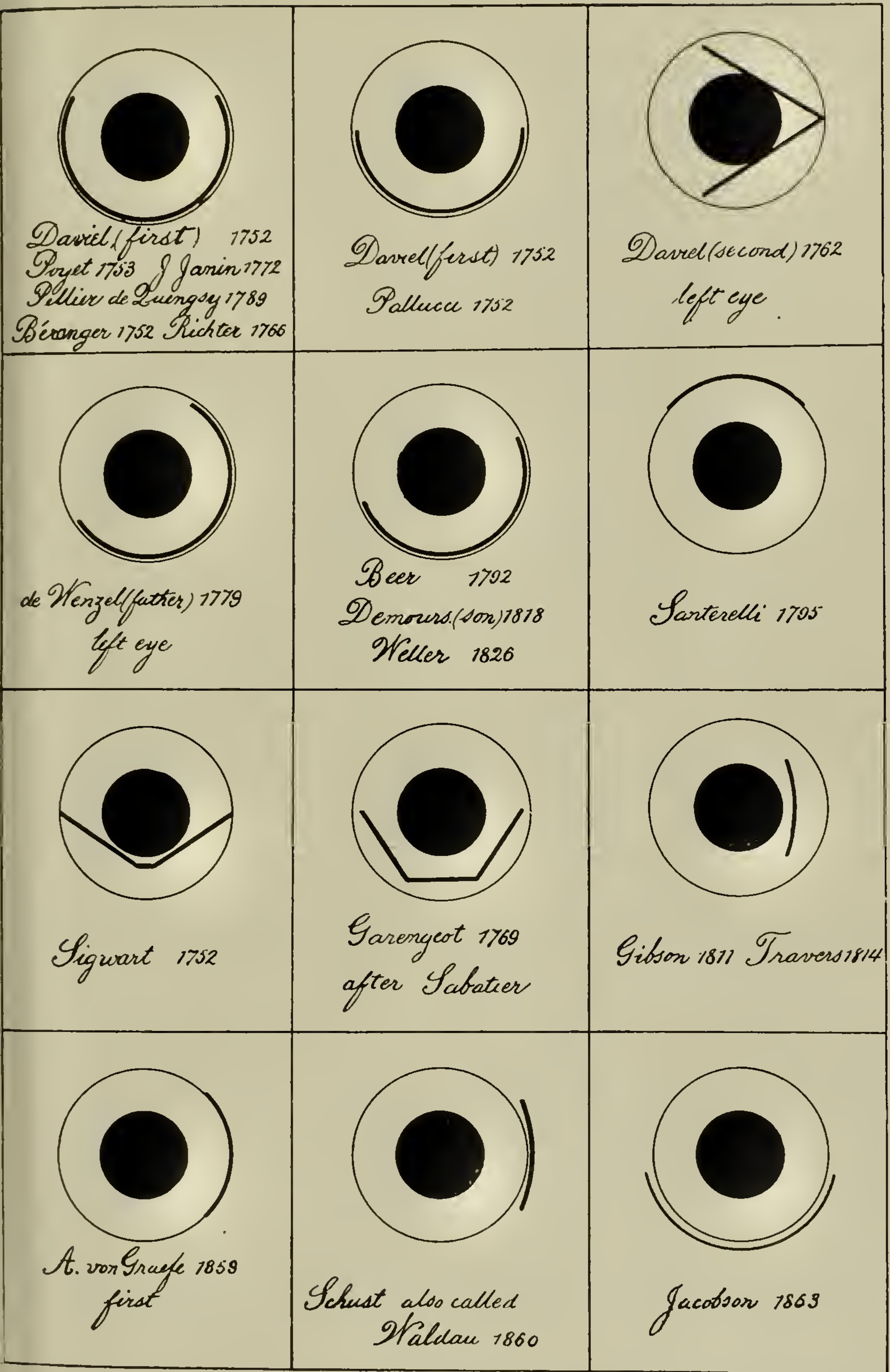


a, b, and c, Daviel; d, Pallucci; e, La Faye; f, Poyfet; g, Sharp; h and I, Tenon; j, Beranger; k, Pomard; l, Richter; m, Pope; n, Casa Amata; o, Demours.

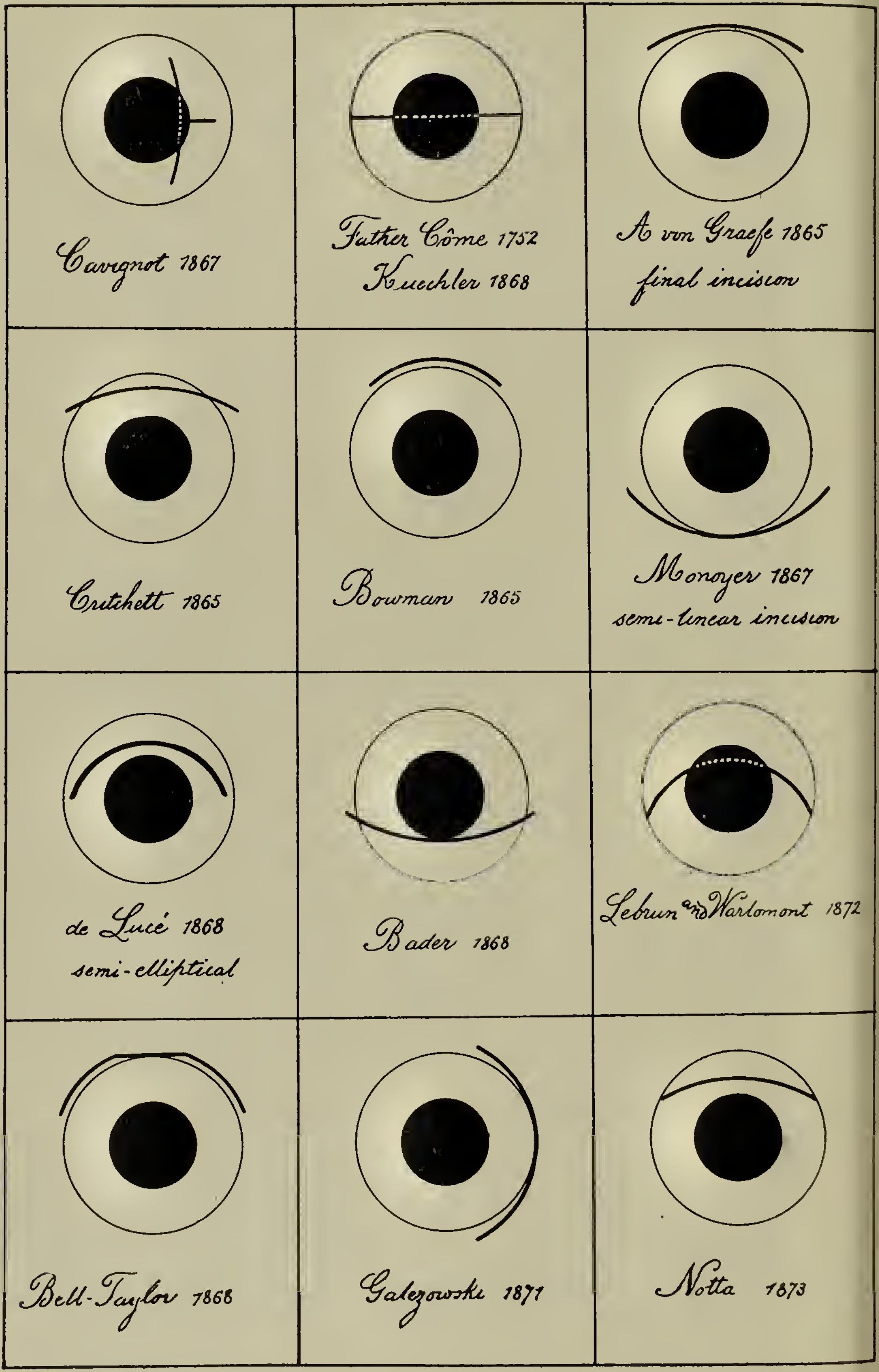
Models of Cataract Knives Prior to 1822. (After Lachmann.)

The von Graefe knife was suited to the work required by it, viz.: the making of a puncture and counter-puncture, and an incision that would be as nearly as possible an arc of the largest possible circle. The original wound began and ended about one mm. from the cornea and a mm. and a half below a tangent drawn through the summit of the circumference of the cornea. After the puncture was made the knife-edge was turned forwards and the most of the wound made perpendicular (or nearly so) to the globar surface. This incision, however, proved to be too short so that in 1867 it was elongated and combined with an iridectomy and a short conjunctival flap, thus giving rise to the modified (peripheral) lineal extraction, to distinguish it from the (1865) (simple) linear extraction without iridectomy. This method was a favorite operation for many years and although other procedures were introduced from time to time, it held its ground until comparatively recent times. Nevertheless, it was noticed that while the proportion of suppurating wounds and panophthalmitis decreased there was rather an increase in sympathetic opththalmia and in cases of "quiet" uveitis. Moreover, the operation required considerable skill; it was difficult to make the incision properly and the delivery of the lens (especially if it were a large one) through the small opening was difficult. Hemorrhage into the anterior chamber, loss of vitreous, prolapse of the iris, cystoid cicatrices, etc., were not infrequent. Among others, Weber sought to remedy these defects by a linear incision made with a broad, lance-shaped knife [on the earlier Santcrelli (1795) and Jaeger (1865) models] with rounded angles. But even this section, which was ten mm. long, was not sufficient to permit of the easy extraction of large cataracts. Henry Howard used an arrow-headed knife of the Weber variety which forms the flap without making a counter-puncture, and renders the operation much more simple. The following is a description of the instrument and some of the steps of the operation in which it was employed:

"It is trowel-shaped; the handle, similar to the handle of all eye instruments, and has a curve from the handle to the blade, to give room for the fingers of the assistant in holding up the upper eyelid, and for the depth from the superior edge of the orbit to the globe of the eye. The blade is rather convex on the back, and concave on the front, having its cutting part on the front edge. Its greatest width is nearly equal to the transverse diameter of the cornea. Its depth is about half the perpendicular diameter of the cornea. There is a guard to the knife to prevent its slipping into the anterior chamber further than is intended by the operator. Now, if with this



Diagrams Showing the Lines of Incision in the Principal Types of Cataract Extraction to Our Own Times. (*Encyclopédie Francaise d'ophthalmologie.*)



Cavignot 1867

Father Côme 1752
Kuechler 1868

A von Graefe 1865
final incision

Critchett 1865

Bowman 1865

Monoyer 1867
semi-linear incision

de Lucé 1868
semi-elliptical

Bader 1868

Lebrun and Warlomont 1872

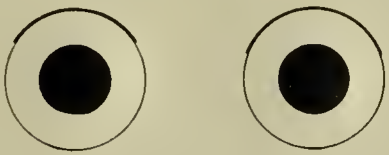
Bell-Taylor 1868

Galezowski 1871

Notta 1873

Diagrams Showing some of the Lines of Incision in Senile Cataract.

knife the upper part of the cornea is pierced at about 1/20 of an inch from the sclerotica, and exactly in the perpendicular diameter, and the handle then brought backwards and upwards, it will bring the back of the blade parallel with the anterior part of the iris; the operator must then push the knife downwards till its point comes near the bottom of the anterior chamber of the eye, at which time its guard will be at the transverse diameter, or nearly so, and the upper half of the cornea will be formed into a flap. That this section may be perfect, the surgeon should be cautious to watch the point of the knife so as to keep it exactly in the perpendicular diameter while carrying it through the anterior chamber; he must also be sure that its back is parallel with the front of the iris. The operator may then cautiously withdraw the knife, but previous to doing so, he should let some of the aqueous humor escape. After the knife is withdrawn the operator and assistant should let go the lids, and the patient must remain as quiet as possible.''



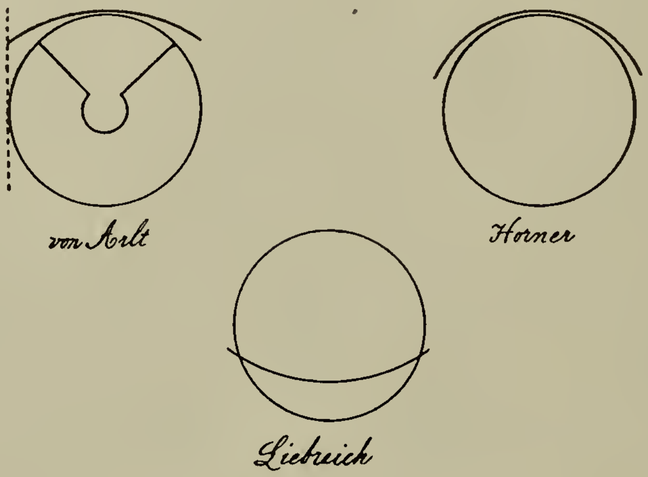
Diagrams of the de Wecker (1872) and Panas (1876) Corneal Sections in Senile Cataract Extraction.

Howard believed that many advantages arose from making the flap with this knife; in the first place there is no danger of the iris falling before the edge of the knife, and the operation may be performed with the right hand on both eyes.

Arlt, his pupil Becker, and Frau Kerschbaumer long employed a slightly modified form of the later Graefe incision, but increased its length to 12 mm.

The foregoing considerations led, in the course of 15 years, to the adoption of several other forms of corneal and scleral incisions. Liebreich, for example, introduced a downward incision without iridectomy, and performed with a narrow Graefe knife that inclined downwards and forwards at an angle of 45 degrees. The puncture and counter puncture were in the sclera, both 1 mm. from the limbus and 2 mm. from the horizontal meridian. The middle of the wound lay about 2 mm. from the sclero-corneal junction.

Even earlier than Liebreich came Küchler who made a direct horizontal cut across the cornea. Although the disadvantages of this incision are at once apparent, yet it had considerable vogue for a time—especially in France—much as the Liebreich incision was for a while fashionable in England. Giraud-Teulon and Vibert, for example, practised a slight modification of it. As proof that there is "nothing new under the sun"—not even a bad operation—Tavignot claims to have established priority of publication, but, as Czermak remarks, neither of these contestants for the honor of discovery was aware that the method had been practised by Frère Côme previous to 1751 and that Daviel, who knew all about it, called it a "comic operation."



Cataract Extraction.
Diagrams Showing Lines of Incision.

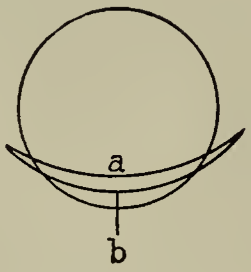
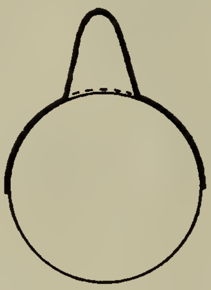


Diagram Showing Incision of Steffans.



Modern section; Showing Small Conjunctival Flap.

Lebrun, about this time, introduced his upper section (made entirely in the cornea) with a short, shallow flap. Both puncture and counter-puncture were made 2 mm. below the horizontal meridian. The knife used was quite narrow and the plane of the incision lay at an angle of about 30 degrees to the iris surface. The summit of the incisional arc corresponded to the upper margin of the undilated pupil. The flap operation again came into vogue but it took the form of an upper section without a conjunctival flap. de Wecker (see figure) was among the first to utilize such an incision, which followed exactly one-third of the corneal circumference. The base of the flap was 11.32 mm. long and 4 mm. high. This did not produce a sufficiently large opening which, by the way, was not generally adopted until the discovery of antiseptic and aseptic measures made safer an increase in the size of the wound.

Types of extraction methods. Although the modern modes of cataract removal are quite numerous, they may be divided into four principal categories. The list comprises the following: (1) The simple (without iridectomy) form of extraction, (2) the combined (with iridectomy) form, (3) extraction of cataract in the unruptured capsule, and (4) variations in one or other of the foregoing classes.

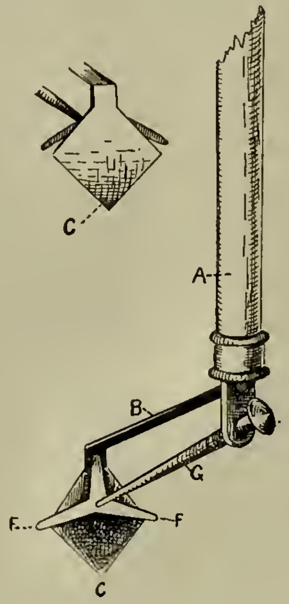
Speaking of the choice of operative measures, Landolt quotes a letter to him from Bowman in which the latter says:

"You are perfectly right; I never laid down a method of extraction of cataract universally applicable. I always operated as seemed best at the time for the individual treated. I cannot doubt that the problem of what is to be accounted the best method in any class of cases will have to be worked out by our successors, and theirs, too; but ever remaining open to modifications to suit the thousand personal circumstances of our patients."

Weber's Cataract Knife.

Must the operable cataract be mature? It was formerly strongly held (and there can be little doubt but that uncomplicated, completely and uniformly sclerosed cataracts are most easily and satisfactorily extracted) that one should wait until the cataract is "ripe" before operating. it matters not how much the patient may suffer from blindness and interference with his daily occupations. For many reasons, which cannot be discussed here, ophthalmic surgeons are now-a-days inclined to operate, for example, on one eye of patients with bilateral cataract—preferably the more advanced—as soon as failing vision interferes with their usual avocation. Brundenell Carter, for example, voices this belief, and Bulson discusses the question in all its relations. Mark Stevenson pertinently remarks:

"A little red reflex or the presence of transparent cortex does not deter me from operating, provided the vision of neither eye is sufficient for the patient's needs, that the cataract is slowly progressive, that the field of projection is good, and that there is no suspicion of serious intraocular disease, e. g., beginning retinal detachment or the various forms of choroido-retinitis. Granting that mild iritis is more common and that an operation for secondary cataract is more often required after operating on immature cataracts, is it not even then better to operate than to keep the patient waiting months and sometimes years? The final results should be as good as after the extraction of mature cataract and vision is restored much sooner, thus aiding the general health.''



Henry Howard's Arrow-Shaped Knife for Cataract Extraction.
[The cut is not in true perspective.]
Fig. 1 A. The handle about four inches long. B. The arm carrying the blade —three-fourths of an inch. C. The triangular blade. D. D. The extreme width of the blade. E. E. The extreme depth of the cutting part. F. F. The guard which prevents penetration to too great a depth. G. The screw which secures the guard, and permits its removal to allow the blade to be sharpened. —
Fig 2 C. The back of the blade (full size).

Beard believes that even if the fellow eye have useful vision it is ''not only justifiable, but advisable to remove the cataract from an eye whose fellow is normal, provided the stage of opacity is fit and the conditions in general are favorable. It is the duty of every individual to obtain what sight is possible in both eyes in order to have a wholesome reserve in the event of an emergency. True, the immediate result is not so gratifying, either to the patient or to the operator, be the operation ever so successful, as the former cannot appreciate the added vision, especially when, as it sometimes happens, an annoying diplopia ensues. Later this will disappear,* whereas, if left alone the cataract would reach a stage not so favorable for extraction. It is also an error to assume that binocular single vision is impossible in such cases.''

Shall the operation be undertaken on both eyes at one sitting? There is almost a unanimous opinion against the removal of bilateral cataract at the same sitting mainly because disaster might follow some unforeseen accident likely to destroy both eyes. Howard Hansell is, however, in favor of this form of double extraction.

Condition of the patient's health in cataract extraction. As the removal of hard cataract is mostly demanded by elderly subjects one must expect to find in them those changes commonly known as senile —especially angio-sclerotic alterations. These, therefore, are no bar to the operation, although it is always proper to have a thorough systematic examination of the candidate for cataract extraction, if for no other reason than that the information thus obtained may modify the pre- and post-operative medication or dietary, and other regulations to which cataract patients are generally subjected. It may also enable the surgeon to insure the patient's comfort or even anticipate possible accidents during and after the operation. For example, patients with the various forms of asthma cannot keep the prone position for any length of time, and there are many old people who when condemned to lie quietly in bed for more than a few hours develop all sorts of symptoms, varying from acute abdominal pains (a frequent experience) to acute mental anguish. These and other idiosyncrasies should, therefore, be the subject of inquiry and consideration as ante-operative precautions.

Extreme old age is not in itself an unsurmountable barrier; indeed, the literature of the subject and the experience of most surgeons prove that many a patient over ninety years old has been operated with success and has enjoyed several years of eyesight thereafter.

Whatever their origin, cough, constipation, diarrhea, and marked insomnia should, so far as possible, be relieved as they greatly add to the dangers of the extraction. Imminent death is, of course, a bar to the operation. It is partly on this score that Herbert declines to

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[* Not always. I have had one unfortunate case that closely resembled that reported by Snellen. (Operationslehre, Graefe-Saemisch Handbuch der ges. Augenheilk., 2nd Ed., p. 52.) After the perfectly successful extraction of a unilateral cataract the patient, a man aged 53, did not become accustomed to the unequal images, and as long as he remained under my observation (several years) was obliged to wear a shade over the eye operated on. This unhappy condition persisted in spite of all sorts of devices—optical and other—intended to relieve the diplopia and mental confusion attendant upon the attempt to go about with both eyes open. Ed.]

operate on cases exhibiting extreme anemia, menstruation, albuminuria with anemia and general edema, or recent syphilis. Apart, however, from such serious considerations as these, the removal of the cataractous lens is not prohibited if, by means of hygienic and other therapeutic aids, the surgeon brings his patient into as satisfactory a state of health as the systemic conditions permit.

Shall we operate at a hospital or in a private house? The surgeon will often be obliged to discuss this question. When he has access to a well-equipped hospital, public or private, he should insist upon the operation taking place there, meantime pointing out to the patient and friends that a serious operation of the projected kind should be done under the most favorable surroundings, and that an operation even in the best regulated house adds considerably to the post-operative dangers. As is well known, the environment of the patient in the average hospital conduces to the success of a cataract extraction in a much larger measure than when done even in the homes of the well-to-do. Should the surgeon decide to do the operation in a private dwelling the preparation of the operating room should approach as nearly as possible the aseptic conditions and surgical conveniences of the regular operating room.

Cataract extraction in the bed the patient is to occupy. There is much to be said in favor of this procedure. Undoubtedly, lifting a blind (and often heavy) patient from the operating table to the litter, stretcher or chair—however gently done—the subsequent journey to the room or ward and the process of settling him in bed are fraught with risks and dangers that he escapes when the eye is operated in the place and posture he is to maintain during the following twenty-four hours. Every surgeon of experience will recall instances where the apprehensive patient (with bandaged eyes) has tightly ''squeezed'' his lids in an attempt to save himself from a dreaded fall off the table or ambulance or from the arms of those who were lifting him off or onto it. Moreover, the ambulance wagon, in transit from the operating room to the patient's bed, often strikes against a door-jamb or an article of furniture, startling the patient and inducing involuntary orbicular contractions that may be just enough to prevent perfect coaptation of the incisional margins, determine an iridic hernia or force some intraocular débris between the lips of the corneal wound.

The objection raised to operating in bed is the difficulty of insuring aseptic surroundings, the need of converting the ward or room into an operating theatre, the necessity for special (headless) beds, and the inconvenience thereby created. While every operator will necessarily be guided by local conditions yet the claim that this method of operation reduces, on the whole, the risk of cataract removal is well worthy of consideration.

The pre-operative state of the ocular apparatus. No operation for the removal of cataract should be undertaken as long as either eye is the subject of an active disease—especially one of an infective character. All forms of conjunctivitis should be treated and, if possible, cured. Diseases of the neighboring cavities that contribute to the congestion or infection of the ocular apparatus should also receive attention. Above all, acute catarrhal diseases of the lachrymal canals—particularly dacryocysto-blennorrhea—should have strict attention. Trachoma, unless it is in the well-advanced cicatricial stage or when its complications are curable, is a bar to operation. A test bandage may be placed over the eye for one night and the discharge subjected to a bacteriologic examination. If pyogenic microbes are discovered the operation should be delayed until the infection is properly treated. As an additional precaution, or if there be urgent reasons for an early operation, a temporary ligature may be placed about the canaliculi, as originally recommended by Knapp, and further employed by Buller, Bulson and the Editor. Gifford advises slitting the upper canaliculus and filling the tear passages with some indifferent substance in cases that present themselves several days before operation. The puncta may also be closed by the actual cautery. If the operation is not an urgent one, extirpation of the sac and other effective treatment of the infection itself should be practised. In the same way pterygium should, generally speaking, be removed before an extraction. Finally, the skin of the lids should be free of disease. Meibomian glands and ducts are likely to harbor pathogenic microbes whose removal is to be desired. Recently an assistant has thoroughly massaged the lids over the eyeball before applying the preliminary bandage as well as on making the final preparation before operating. This process is facilitated by the presence of the White's ointment introduced for the purpose of active sterilization.

Arcus senilis is no particular obstacle to the operation, although it is well to avoid this corneal alteration while making the incision.

There are very few pathological processes involving the iris that act as a barrier to a successful operation. Nevertheless, it is desirable that the patient should have a healthy iris and that the pupillary reactions should be altogether, if not quite, normal. Herbert believes that an eye exhibiting normal pupil reactions is not likely to be the subject of complications.

The routine extraction of uncomplicated senile cataract. Having fully treated all forms of local infection the routine preparation of the patient largely consists in rendering as sterile as possible the conjunctival sac. We know, from the labors of many bacteriologists, that while it is impossible to render the sac absolutely sterile, yet the deleterious action of morbific germs may be largely neutralized by simple cleansing. Stevenson begins the sterilization a week before the operation and this is regarded as good practice, especially when there is any discharge from the eye. He uses an eye-cup (which can be easily sterilized with a saturated solution of boric acid), and furnishes patients with the following instructions:

"The eye bath, about one-third full of the solution, should be gently pressed against the closed eyelids while the head is slightly inclined forward. The head is then slowly thrown backward, the lids are opened and closed repeatedly and the eye bath moved slightly from side to side, during time required to count 40, so that the solution may completely wash out the eye sac. The head is then again inclined forward when the eye bath is removed (the eyelids remaining closed for a few minutes), and its contents, which should be used for one eye only, thrown away. The bath is also used on the morning of the operation and about an hour before operating, after which a sterile eye-pad is fastened in place by adhesive strips."

In addition to this simple form of cleansing I am in the habit of having the eye-brow shaved, and the cilia cut off close to the lids. I am aware that there are many objections to the removal of the eyelashes and eye-brow, but it is well known that hairs furnish a fruitful nidus for germs. Moreover, during the operation they frequently get in the way and may act as an embarrassment to the operator. If, however, the patient raises much objection to their removal one may compromise by cutting off a few cilia from the outer and inner canthi and clip the hairs of the eye-brow when these are long. Then I insist upon scrubbing the brow with green soap or benzine (or both) as an additional precaution. I do not like the application of benzine to the eye-lashes as it generally gets into the eye and produces considerable congestion of the globar vessels. The conjunctival sac is then filled with White's ointment (the night before operation) and a triangular bandage applied. The eye-pad of this dressing is removed when the patient is on the table and again the conjunctival sac is gently irrigated with a Todd or other apparatus, the stream of warm boric acid or normal salt solution being directed towards both sulci, so as to wash out their contents. The whole region of the eye is then thoroughly cleansed of the remains of the White's ointment. In addition to these precautions the neighboring facial skin is well rubbed with warm boric acid solution. The nose should receive quite as much attention as the lachrymal apparatus and not only should all nasal affections have rigorous preoperative treatment, but attention given to spraying the nasal cavities either with the solution suggested by Lippincott—1 to 2,000 of potassium permanganate—or with some similar liquid.

In this connection one is reminded of the observations of Napp on 171 cataract patients. He concluded that where no bacteria were found before operation, but were discovered after the extraction, they generally got there *under the bandage.* As transmission from the nose may be excluded, very likely some germs have been previously on the conjunctiva which did not come in contact with the platinum. A small percentage of conjunctival sacs were found, after operation, free from bacteria. The number of bacteria before operation is generally increased after it. The sometimes considerable number of bacteria, pathogenic or benign, however, appeared to have no influence on the healing of the wound. Here the formation of a large conjunctival flap, and its careful adjustment, are essential. The occurrence of bacteria, generally non-pathogenic, may occasionally cause conjunctivitis. A certain disposition of the individual or the mechanical irritation of the conjunctiva by the grasp of the fixation forceps has some influence but these inflammations yield to proper treatment.

Many operators, dreading the multiplication of germs, have discarded all dressings. Since, however, the increase of bacteria under the bandage has no influence on the healing of the wound, the author sees no reason to abandon a method of treatment which secures rest and protection for the eye operated on, especially as investigations in the clinic of Axenfeld have shown an increase of bacteria under a wire mask, whether the eyes were kept closed or open.

Other preoperative considerations. Although the preparation of the surgeon and his assistants, the patient, the instruments, the dressings, etc., preliminary to operations will be found considered elsewhere yet there are several matters introductory to a description of cataract extraction of such special importance that they, even at the risk of repetition, should be mentioned here.

Wherever the operation be performed the patient should be admitted at least 24 hours in advance so as to give sufficient time for the necessary preliminaries. If the patient be accustomed to taking a full bath he should have one, otherwise a sponge bath is in order. It is also desirable that a cathartic (preferably combined with calomel) should be given the first evening, followed by some saline mixture the following morning. In this connection it is generally advisable to consult the patient as to the form of laxative that he is in the habit of using. Elderly people generally have a choice of these remedies which it is wise to consider.

The food should be as light as possible and here, too, the patient should be consulted in framing a diet-list. As before stated, the regimen ought to be consistent with the findings of the systemic examination. As a rule, however, a light, easily-digestible diet, plenty of water, a well-ventilated room and such other comforts as the patient has been accustomed to will form the best basis for his hygenic treatment.

The patient should understand that his assistance is highly desirable before, during and after the operation, and one should not neglect making to him this statement which has a tendency to induce his active co-operation, gain his confidence and to place both surgeon and patient upon a proper footing. I am in the habit of having a quiet talk with each patient upon two or three occasions preceding the operation, of exercising him in rotating his eyes in various directions, everting the lids, etc., and endeavoring to get him accustomed to my own manipulation of the parts about to be operated. It is believed wise to do this not only a few minutes before the operation but on other occasions. These manipulations tend to familiarize the patient with the idea of operation and should rarely be omitted.

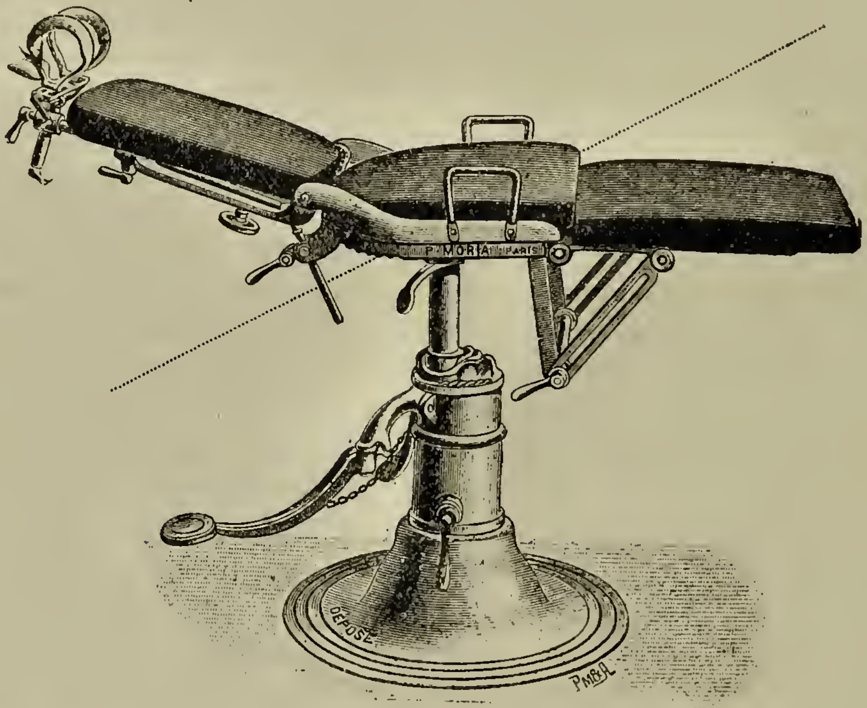
The question of *cataract extraction as an office operation* occasionally comes up. There can be but one opinion on such a vital subject. Even with all the advantages and facilities of hospital practice the operator is largely at the mercy of his patient in the attempt to obtain the best possible vision. How, then, can any surgeon afford to take the added risks of an operation in an office and the sending of the patient home immediately afterwards? This question was many years ago discussed in its various relations by a number of experienced operators, and it was pretty definitely decided that, although a cataract extraction *may* not be followed by disaster if performed in an office and the case subsequently treated as an ambulatory one yet it is, on the whole, a highly undesirable proceeding and ought to be adopted only under exceptional circumstances. (See *Ophthalmic Record,* 1894, Vol. 4, pp. 7, 59 and 213.)

Further preparation of the operator and patient. The operator should wear a cap, to prevent dandruff and other infective material from falling upon the operative field from his hair. Both surgeon and patient should wear a mouth and nose mask, to prevent globules of saliva and other infective exhalations from reaching the eye, either from the patient or from the operator. It is a rational proceeding, when one considers that the breath and saliva are both likely to contain cocci, that at least the mouths of patient and operator should be shut off from the operative field. In addition I am in the habit of covering the remainder of the face with two single layers of sterile gauze wet with warm boric acid solution. An opening is made in this, corresponding to the margins of the orbit, large enough to admit the speculum and to allow of the usual operative manipulations. After pressing this covering firmly upon the skin the wet gauze will adhere closely and not interfere with the surgeon's work. Thus prepared there is little or no danger of infecting the surgeon's hands or his instruments by contact with any portion of the patient's face.

Mark Stevenson, for the purpose of directing the patient's breath away from the eye, advises that a strip of adhesive three or four inches wide and six or seven long be covered with gauze on its adhesive side, with the exception of about one-half an inch of its width along one margin, throughout its entire length. By this upper uncovered margin it is fastened across the bridge of the nose and both cheeks, an inch or more below the eyes, so that it hangs down over the nose and mouth and directs the patient's breath and saliva away from his eye. It should then be covered with sterile gauze. He also advises that, instead of the usual surgeon's mouth and nose mask, a strip of gauze a yard long may be drawn over this frame so that the ends meet below. The lower ends of these strips for a distance of ten or twelve inches are then split by scissors and the two halves, one on each side, tied or fastened by a safety pin behind the neck so that the gauze hangs over the mouth and passes under the chin around the neck. As many layers of the gauze may be used as are thought to be necessary. With this appliance the surgeon's breath will not pass upward into his own eyes or blur his operating glasses, but pass out to the side, and all saliva or excretions from the nose will be arrested in the gauze; and he can still talk and breathe freely.

Any preparation that can possibly be made before the patient's arrival in the operating room should be effected, mainly that the conscious subject of it should not have too long to wait before the welcome announcement that "it is all over." I have sometimes been obliged, owing to incomplete arrangements or incompetent operating-room assistance, myself to wait, and have seen the same occurrence with other surgeons, until the unhappy patient has been brought into such a state of apprehension and excitement that he was unable to give any assistance towards a proper completion of the operation.

Bringing the patient to the operating room. This is sometimes of importance, especially in the case of nervous persons whose confidence one wishes to obtain or retain and whose courage one desires to strengthen. When a patient is ceremoniously wheeled or carried into the room he generally imagines that something dreadful is going to happen, whereas if he can be allowed to walk in and the matter treated as of little moment, he is not so likely to be excited by subsequent proceedings. On reaching the operating table he should be directed to mount it by the aid of a strong step or box, then to sit down upon its middle, then to lie down and rest his head upon the thin, firm pillow provided for the purpose. Some operators use a special operating table, or chair, but as a rule any form of operating table of modern construction will be sufficient. While the assistants and nurses are preparing the instruments, dressings and other applications, it would be well for the surgeon, who has in the meantime been dressed and prepared for the operation, to superintend the placing of the patient upon the table and in as quiet and gentle a fashion as possible direct him how to give his assistance during the operation. It is just here that the operator may become so acquainted with the subject upon which he is to operate as to avoid many of the accidents that are liable to happen to a suspicious, frightened, or otherwise demoralized patient. It is also at this time that the patient may be instructed how to turn his eyes in various directions and what to do



Morax Operating Chair, Especially Adapted to Cataract Extraction.

under certain contingencies. If he cannot easily fix his eyes he may be directed to look towards his feet, or straight forward, or at the face of the surgeon who is speaking to him. A certain amount of handling of the patient's face and eyes is also desirable, that he may become accustomed to the subsequent operative manipulation. I generally wash out the sac, cleanse the eyelashes, massage the lids, or perform some other part of the preliminary sterilizing. It always does good to reassure the patient that he will not be seriously hurt and I generally tell him that if he will be quiet, and not under any circumstances ''squeeze'' up his lids, that there will be little or no pain. There are certain stock phrases which may, with considerable benefit, be employed on such occasions. For example, I usually say to the patient, ''It will be time for you to get nervous when you notice that I am nervous,'' and ''Most people never know when the operation has begun or when it is over.'' It is also a good plan not to allow anybody in the room to speak above a whisper. I generally remark in the presence of the patient that the operator ought to do all the talking and the other people in the room, including the patient, should be mere listeners. When that is accomplished the surgeon should never raise his voice, never speak quickly, but should talk and act quietly and deliberately until the patient has left the room. If the operator has any fault to find with the preparations, with any of his assistants, or with himself, he had better do it when the patient is not present. It need not be added that loud talking, gesticulating and storming about the room have no effect other than to fluster and demoralize the patient and to jeopardize the success of the operation.

Shall we *operate on the cataract patient in his bed?* The experience of many operators leads them to believe that the quieter the patient is kept immediately after an extraction operation the more likely is the result to be good. In consequence of this many surgeons insist upon operating upon a cataractous patient in the bed and in the room that he is to occupy after the removal of the lens. I am quite convinced from my own experience that this is a highly desirable procedure, and urge upon those whose practice is otherwise to make the experiment.

Just before the operation and after the cleansing of the whole field —an act that should be carried out with great care and without doing anything that will irritate or be unpleasant to the patient—it is my custom to put a drop of cocain solution into the fellow eye. This insures the minimum danger of the patient's ''squeezing up'' both eyes should a drop of solution fall into the fellow organ or should it be touched by the assistant or by any portion of the dressing. During the anesthesia, which should now follow, a thin layer of absorbent cotton, wet with warm boric acid solution, is placed upon the closed lids and the patient told to keep both eyes shut until he is asked to open them.

Local anesthesia. My favorite anesthetic is a sterile mixture of holocain (1 per cent.) with cocain (4 per cent.). One drop of this combined solution is instilled into the eye every two minutes for ten minutes, the operation being begun in from ten to fifteen minutes after instilling the first drop. As I generally make a conjunctival flap, I believe in instilling with, or immediately after, the last drop of cocain, one drop of a 1 to 1,000 solution of adrenalin or suprarenalin. Used in this way it checks the bleeding which, to my mind, is the most serious drawback to this form of extraction.

The idea that filling the conjunctival sac with the anesthetic solution, or its application every few seconds for a long time, will have any effect except a harmful one should be permanently discarded. The conjunctiva and cornea will not absorb more than a certain amount of liquid, it matters not how often or how much of it is applied. This very unnecessary dosage results in a waste of expensive material, a reduction of the tonicity of the globe, post-operative hemorrhage, possible exfoliation of the epithelium of the cornea, as well as in danger of poisoning the patient. In the interval between these instillations, and when nothing is being done to the eye, the lids should be kept closed and protected by a cotton pad wet with warm borated solution.

At any stage of the operation it is desirable, when the patient's eyes are closed or covered (and some manipulation is about to be done), to place a finger upon the forehead so as to warn him that "something is coming;" then to tell him what that "something" is, whether it be to put a drop into his eyes, a speculum between the lids, or what not. Of course, it is not necessary to definitely specify the act that is to follow, but merely to give him an idea of it. This strengthens the patient's confidence in the operator, prevents him from wincing or squeezing up his lids, and will generally be found a useful plan to follow.

The illumination. As this important subject will be fully treated elsewhere it will only be necessary to say here that my preference is for natural light when a good northern illumination can be had. Otherwise a hand electric lamp of about 10-candle power—which is about equal to the so-called 16-candle power burner—so shaded and held by an assistant that the light falls upon the field of operation obliquely from the side of the table opposite the surgeon, is the best form of artificial light one can have. Some operators wear a head mirror, others like a light focused upon the patient's eyes by means of a strong convex lens, and still others like direct sunlight; but the diffuse, soft light that falls from the upper part of a north window—cross lights being shut out—is less irritating to the patient and better adapted to the operator's vision than any other.

The use of a lighted candle as a fixation object for the patient during operations for cataract. Priestley Smith has not published this device but demonstrated it to many friends—amongst others to the late Professor Snellen who adopted it permanently. He operated in a black-walled chamber by light from a window, but the writer usually prefers to darken the ordinary operating room and to use a lamp for his window—cross lights being shut out—is less irritating to the patient to direct his eye just as the operator may desire.

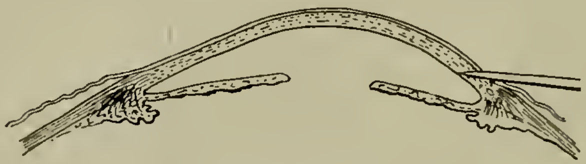
Position of the operator and his assistants. Unless he be ambidextrous the surgeon should stand at the head of the table when operating on the right eye, and to the left side for the left eye. Webster Fox and others use an operating table out of whose left side a segment is cut so that the body of the operator may be better accommodated while operating on the left eye and, for some surgeons, this is a considerable advantage.

The two assistants should be dressed and prepared exactly like the operator. The first assistant, in charge of the instruments, stands on the left, and the second, if there be one, on the operator's right.

Putting in the speculum. The assistant in charge of the instruments now hands the speculum to the surgeon who, addressing the patient, says, "This is something I am going to put into your eye to help you keep your lids apart, without hurting you." Holding the body of the speculum between the thumb and index finger he asks the patient to look down and then deftly and gently places the upper limb of the blepharostat in place. Then the patient is asked to look straight ahead, the lower lid is pulled down and the lower limb put in place, when the spring of the speculum is allowed slowly to separate the lids. If there is any disposition on the part of the patient to wink or blink with either eye, or if the lids do not separate sufficiently under the pressure of the spring alone, the patient should be asked to open the eyes wider and the surgeon should gently separate the limbs of the blepharostat.

The cornea and sac are now gently flooded with warm boric acid solution, which is soaked from the corner of the eye with a damp cotton sponge. Before this irrigation the patient should be warned that "this is only a little warm water to wash out the eye." The surgeon is now quickly but quietly handed the fixation forceps and the cataract knife. Some surgeons direct the second assistant to place his left hand on the patient's forehead and to press firmly on the brow and upper margin of the orbit, keeping the hand and forearm well down and out of the way of the operator. This proceeding is useful in preventing spasm of the orbicularis and "squeezing" of the lids.

Fixing and steadying the eyeball. By common consent the area of fixation is close to center of the lower-inner fourth of the limbus. The forceps are placed against the eyeball in this region closed, and then allowed to open 2 or 3 mm. The loose, underlying structures are thus put somewhat on the stretch so that when the jaws of the forceps are again closed they do not pick up too much of the conjunctiva and do not lacerate that membrane. Some pressure should be exerted at the time of closing the forceps so that a good, deep bite of the tissues is taken. I always use and much prefer small or medium-sized forceps without catch or lock. The teeth should not be too pointed nor should they be too dull. In the first instance they will tear or cut the conjunctiva, and in the second their grasping power is not sufficient. Some operators twist the forceps half way around so as to gain a better hold upon the eyeball but this maneuver sometimes results in laceration of the conjunctiva and, in any event, is generally unnecessary if a firm hold is taken upon the subconjunctival tissue by a proper adaptation of the forceps' teeth.



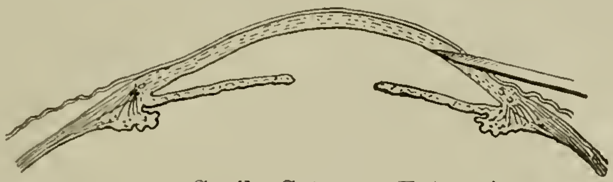
Senile Cataract Extraction.

The puncture properly made. The point of the knife has penetrated the anterior chamber exactly at the limbus.

The hand holding the fixation forceps now rests upon the patient's nose and opposite cheek and this position is steadily maintained, care being taken neither to press upon the eyeball nor to drag the conjunctival tissues away from it.

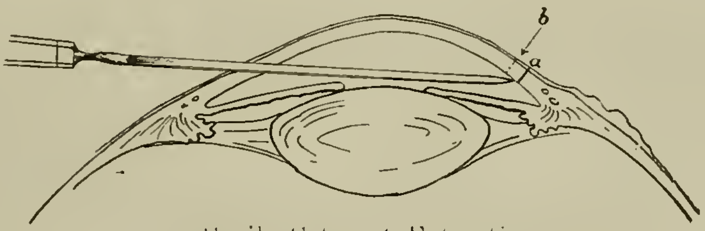
The puncture and counter-puncture. The surgeon now examines for an instant his knife edge—to insure its upward direction. He rests his little finger on the cheek of the patient and tells him to look down at his feet. Some surgeons direct the patient to hold both eyes and mouth open, and this is generally a good plan as it assists in hypnotising the susceptible patient and directing his attention away from the operative work that is being done upon his eye, and so renders less likely orbicular spasm or deliberate "squeezing" of the lids.

The handle of the knife, held as one would a pen, is elevated at an angle of 45 degrees to a tangent of the corneal curve, and a puncture into the anterior chamber made at the apparent sclero-corneal junction just above the horizontal diameter. As soon as the point of the knife has entered the anterior chamber the handle is depressed so that the blade may be pushed across the anterior chamber nearly parallel with the plane of the iris and towards the center of the pupil. When the pupil is reached the knife handle is again moved towards the patient's feet and a counter-puncture made as nearly as possible at a point exactly opposite the puncture.



Senile Cataract Extraction.

The puncture badly made. The knife point has not reached the anterior chamber but has "split" the cornea and is buried in its substance.



Senile Cataract Extraction.

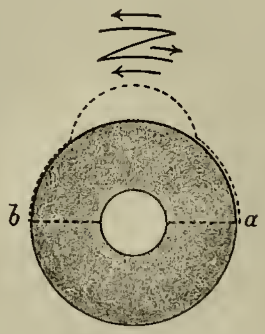
The counter-puncture should be made at a, although in obedience to the laws of refraction, the point of the knife appears at b.

Then by firm, steady and regular to-and-fro movements—pushing and pulling—the blade cuts its way towards the upper limbus. First, the point is pushed forward and inward towards the nose, then it is pulled outward and upward towards the temple, and these motions alternated until, always following the apparent sclero-corneal junction, the middle of the blade reaches the uppermost sclero-corneal margin.

The knife blade is then given a one-eighth turn backwards and made to cut its way out beneath the conjunctiva so as to make a small flap of the latter tissue, from 3 to 5 mm. wide and long. During the corneal incision care should be taken that the point of the knife does not stab the lids or facial skin. Moreover, the corneal section should not be completed with a jerk as this procedure sometimes causes the patient to make involuntary movements or to "squeeze" the lids together.

Advantages and disadvantages of the conjunctival flap. Whatever form the corneal or sclero-corneal incision may take it is undoubtedly desirable to combine with it a flap from the conjunctiva. Although there are some disadvantages attending this maneuver the advantages are undoubted. These considerations are fully discussed by Herbert, from his large experience.

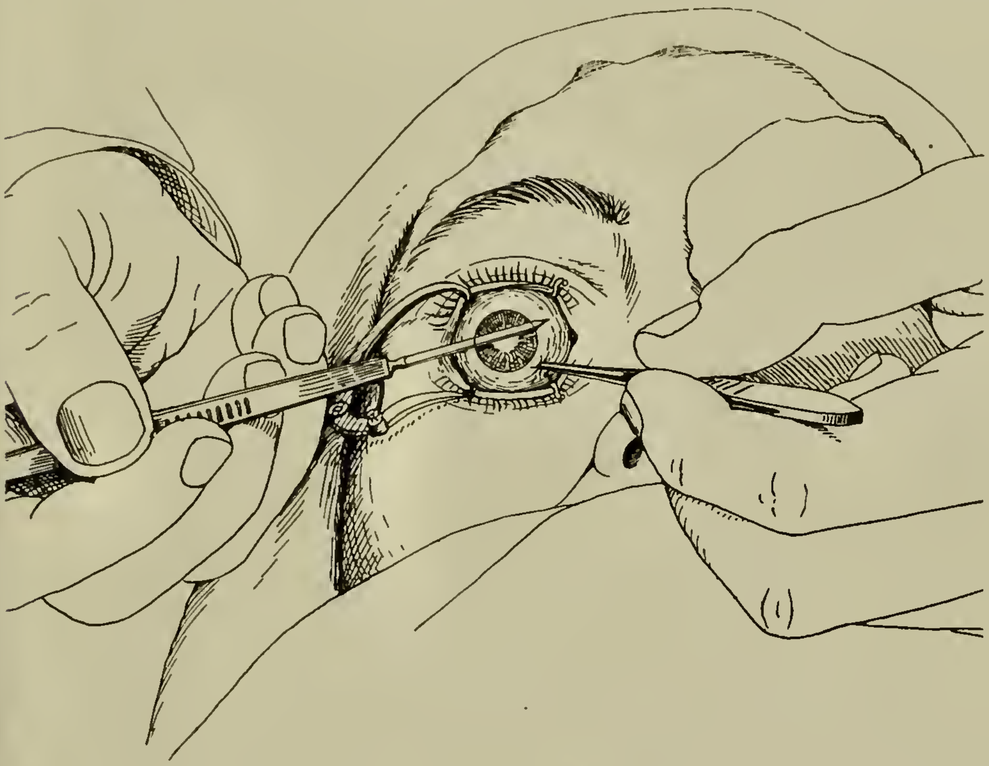
The advantages are: 1. The chief function of the conjunctival flap is to serve as a protection against infection. As a covering for the wound it bars the entry of micro-organisms from the conjunctival sac after the operation. The more complete the covering, therefore, presumably the more effective should it be, especially in eyes where the vitreous tends to press the corneal flap forward. 2. The rapid adhesion of a conjunctival flap to the underlying tissues must undoubtedly tend to prevent iridic prolapse. But this statement needs some qualification. Since a cataract incision largely covered by a conjunctival flap must be at least partly sclero-corneal, this peripheral situation of the section, as compared with one in front of the limbus, is calculated to more than counterbalance any benefit derivable from the conjunctival covering. For another reason, any value attributable to the conjunctival appendage as a preventive of prolapse is restricted mainly to the smaller conjunctival flaps. 3. The use of the flap makes the complication of delayed union of the wound, as shown by non-retention of aqueous, a rare and almost a negligible one. Should the complication occur, it will not persist for long, and will not require treatment, and there is no fear of down-growth of surface epithelium into the anterior chamber, with its subsequent liabil-



Senile Cataract Extraction.

The arrows indicating the knife movements after the puncture, a, and counter-puncture, b, have been made in the left eye. The black lines show the corneal and conjunctival section.

ity to induce probably incurable glaucoma. 4. Herbert attributed the almost complete exemption (in Bombay) from secondary glaucoma to the general use of an extensive conjunctival flap. A permanently filtering cicatrix—rendering rise of tension practically impossible—appears to be the constant and inevitable result of any recognizable separation of the sclero-corneal incision under the conjunctival covering. 5. A minor advantage of the conjunctival appendage is in the use that may be made of it to draw open the wound during operation, for the iridectomy and in the expulsion of the lens.



Senile Cataract Extraction on the Right Eye. The counter-puncture has been made and the knife is being thrust or pushed firmly forwards and upwards to make most of the limbus section on the nasal side.

The disadvantages of the conjunctival flap are: During the operation the flap may be a little in the way when the iris is being cut; but the chief trouble from it then is the hemorrhage into the anterior chamber, which is to be expected more or less with any extensive flap unless adrenalin * has been instilled. This blood is not only a nuisance at the time, interfering with the capsulotomy and the

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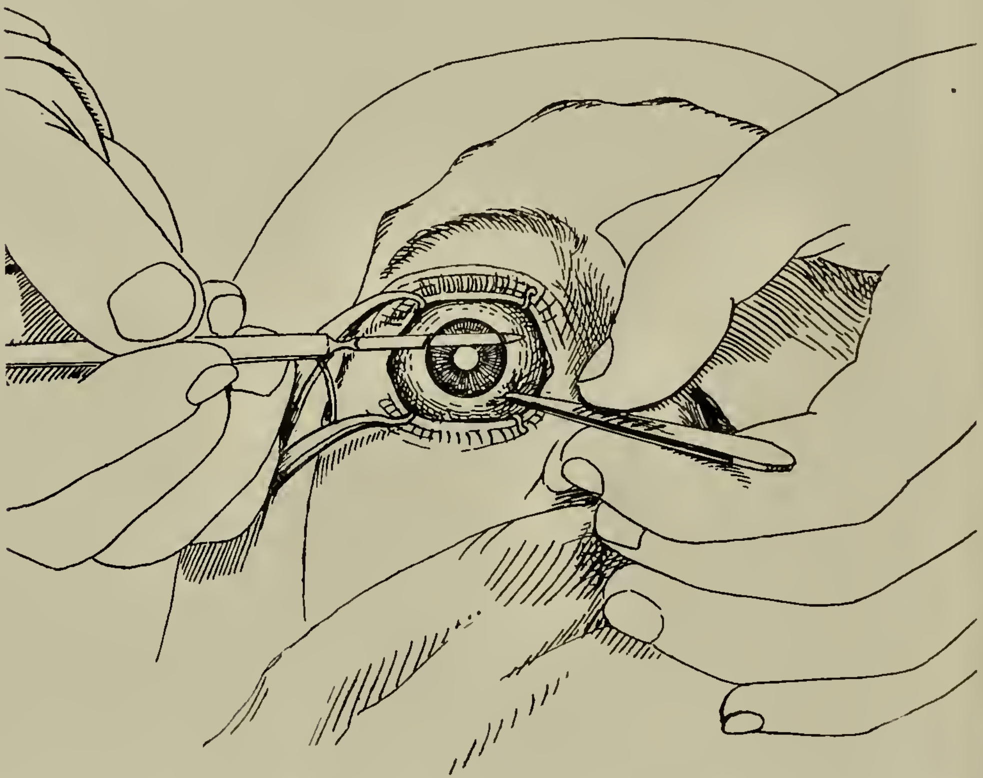
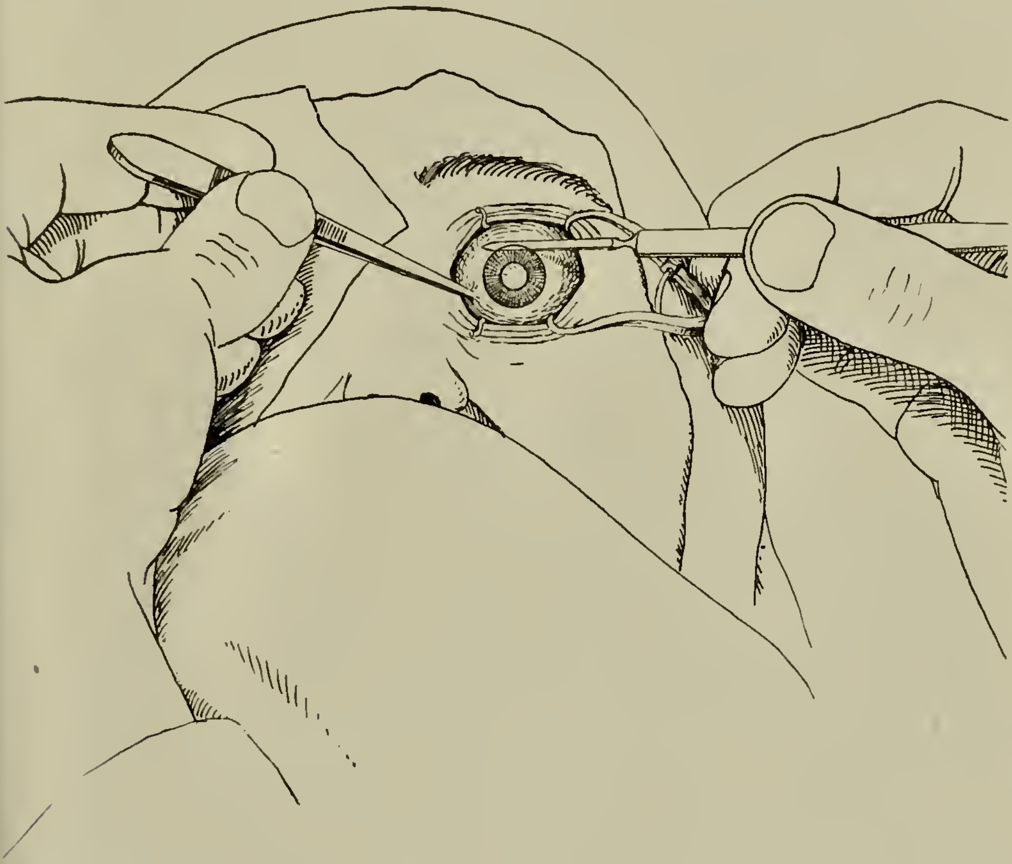
* I question the power of any hemostatic solution to arrest entirely the flow of blood from the cut ends of the sclero-conjunctival vessels. I have employed, with the conjunctival flap incision, almost every form of these valuable adjuncts and find that, while they assist the hemostasis, bleeding into the anterior chamber is not uncommon, sooner or later, after the conjunctival flap is made.

removal of cortex, but afterwards as well. A little of it may also become organized, causing permanent after-cataract and synechiæ. The bleeding is to be more carefully guarded against in intracapsular extraction, since here the blood cannot well be washed away. Still, these are not very serious matters. Also may be mentioned as a slight drawback the difficulty experienced in outlining the flap exactly as one wishes. After operation the separation of the lips of the deep wound, which takes place under a too complete conjunctival covering, presents very decided disadvantages to set against the advantage already claimed, namely, the value of this separation as a safeguard against secondary glaucoma.



Senile Cataract Extraction on the Right Eye (continued). The knife handle is being pulled away from the globe—at the same time being pressed gently upwards —so as to make most of the section on the temporal side.

This separation of the deep wound margins may be responsible for (a) permanent astigmatism, occasionally considerable in amount; (b) of such accidents as sometimes happen to eyes that pass through a prolonged low-tension period; and (c) the occasional, late, gradual incarceration or prolapse of the iris in a wound gaping under the conjunctival flap, seen by the writer especially after combined extraction. This occurrence is, however, too infrequent, even with a very extensive conjunctival flap, to greatly qualify the statement just made about the use of the flap as a preventive of prolapse. Moreover, this late prolapse, always small, is removable without any particular risk or difficulty. And all of these drawbacks apply only to a covering left considerably larger than necessary. They can be avoided by trimming the flap, except where the vitreous presenting in the wound renders this inadvisable. Very rarely the flap fails in its purpose through becoming folded down over the cornea.



Extraction of Senile Cataract, Left Eye (continued). The last stage of the section. Forming the conjunctival flap.

To this experience of Herbert may be added that of C. F. Clark, who thinks that a conjunctival flap does not increase, but on the contrary, diminishes the amount of the operative astigmatism.

The advantages of the conjunctival flap in the simple operation are thus set forth by Santos Fernandez: 1. The bandage can be taken off in 48 hours. 2. There is less operative reaction. 3. Complete absence of photophobia. 4. Offers greater resistance to the pressure of cortical remains. 5. Covers completely the corneal wound and thus avoids infection through it. 6. Absolutely avoids prolapse of the iris, or anterior synechiæ. 7. In case of vitreous prolapse the eye is guarded against infection and this grave, at times unavoidable, accident is less harmful than before. 8. In private practice it does not bother the patient and in hospital practice shortens greatly his stay in hospital, as he can be discharged on the fourth day and only routine precautions need be taken.

At this stage of the operation the fixation forceps are usually removed but if the patient be a "good" one the speculum is permitted to remain in place. If, however, there is any doubt as to whether the patient will attempt to "squeeze" his lids together it is better to remove the blepharostat and support the eyebrow, as previously directed.

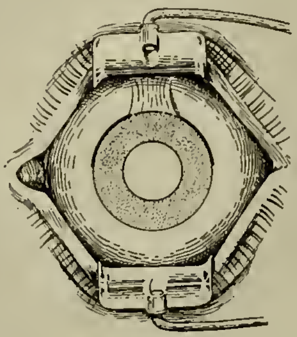


Diagram Showing the Relative Positions of the Corneal Section and the (small) conjunctival flap.

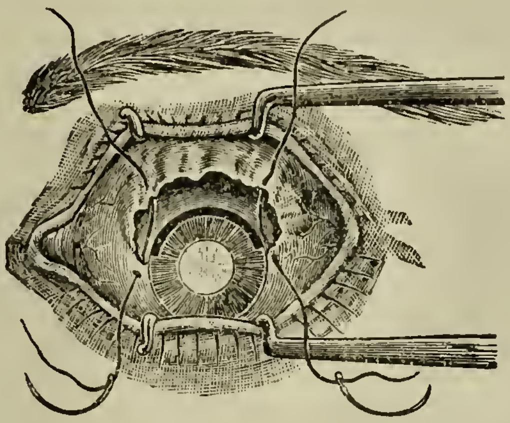
If the section be made in the manner mentioned the margin of the iris will not fall in front of the knife. Should it do so it is best to proceed with the operation as just directed, although a certain "scalping" (iridectomy) will result. The methods commonly employed to prevent or obviate this accident will be considered later.

If the incision has followed the sclero-corneal junction and a conjunctival flap has been made in this way there will probably be some bleeding which the adrenalin does not entirely prevent. Should this be produced it is better to wait a moment or two, gently flushing the eye with warm boric acid solution and endeavor to soak up the diluted blood with a damp, cotton sponge. During this process the patient should be quietly told that "everything is all right," and that "the operation will soon be over."

The flap of conjunctiva should now be turned or pushed over upon the cornea with the closed iris forceps or a spatula. It is a good plan to apply to the surface thus exposed a single drop of a mixture of adrenalin and cocain.

Van Lint's method of the sliding flap in cataract operations. The conjunctiva is undermined and separated around one-third of the upper margin of the cornea. Two black silk threads are inserted through the loosened conjunctiva and brought out in the attached conjunctiva, near the cornea-scleral margin below, on each side of the cornea. The corneal incision is made in the regular way, sufficiently large to allow the cataract to be delivered without bruising the cornea. After rupturing the lens capsule with the bent cystotome, the ordinary method is applied to deliver the lens and any cortical matter which may remain behind. The iris is then gently stroked into place by a very flat spatula or Daviel spoon. This insures a round, black pupil.

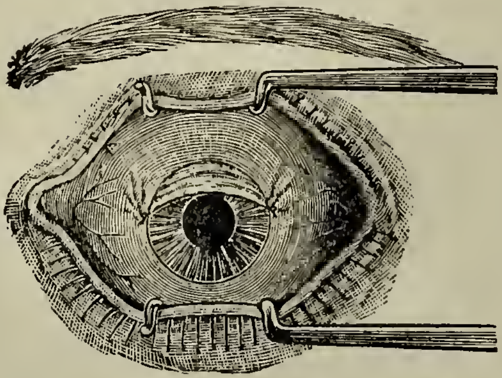
Up to this stage of the operation one has practically followed the ordinary, simple method. The silk threads are now tied, first on one side of the cornea, then by gently raising the other side of the flap of conjunctiva, by means of the second thread it is brought downwards and over the line of incision, and tied. This apron covers about one-fourth of the cornea. After the speculum has been removed, Fox (*Ophthalmology*, Jan., 1912) passes a flat curved spatula underneath the conjunctiva and gently strokes the edges of the corneal flap into place. Upon examination one finds the pupil round and in place, and the conjunctival flap supporting the line of corneal incision. This gentle pressure, evenly distributed, prevents the eye currents from washing outwards any part of the iris.



First Stage, Van Lint's Cataract Method. (Fox.)

Advantages of the procedure. In the first place the operation for cataract with sliding of the conjunctiva is exceedingly easy of execution. It reduces itself to the classical simple extraction, to which is added the conjunctival dissection, which in ocular surgery is an elementary matter. Further it will protect against prolapse of the iris and infection. In effect by this procedure the edges of the wound are intimately applied the one to the other. The eyeball is thus fixed and the iris finds no place of exit. The conjunctiva has a tendency to retract; it exercises a pressure from before backwards; it consequently pushes the anterior lip to the wound against the posterior lip in a constant manner. The conjunctiva drawn by sliding in front of the wound throughout its extent acts as a real splint and assures a good coaptation, which is of prime importance for rapid cicatrization.

Nothing, Fox believes, proves better the efficacy of the procedure against prolapse of the iris than the following fact: In a case where the spatula failed to reduce the iris, the pupillary margin of which protruded in the wound, Fox noticed at the moment that he tied the second knot the iris took its primitive normal position behind the cornea, and presented a perfectly round pupil.



Second Stage, Van Lint's Cataract Method. (Fox.)

As to the rôle which it plays against infection, the conjunctival flap covering all the wound, one knows that it is most efficacious. That is easily understood. The wound thus covered is eliminated from the conjunctival sac, a medium rich in microbes, a source of infection for the eyeball. The cicatrization can go on in an aseptic medium, and there is no fear of development of microbes in the interior of the eye, seeing that the well sterilized instruments do not introduce any microbes into it.

The iridectomy. If the operation is on the right eye and all the usual indications of a favorable form of cataract be present, one should endeavor to complete the removal of the opaque lens without operative interference with the iris; otherwise, and in the majority of cases, I prefer to do an iridectomy. In that event it is well to notify the patient that he may now experience a little discomfort but that he must under no circumstances "squeeze up" his eyes but bear with just a little momentary pain. The surgeon should again ask him (always in a very quiet and low voice) to look down and keep both eyes, hands and mouth open. Then, holding the iridectomy scissors (closed) with the right thumb and middle finger, and a pair of small iris forceps (also closed) with the left hand, introduce the forceps into the anterior chamber. When the point of the forceps reaches the margin of the iris, the jaws of the instrument should be opened and the iris grasped at this point. Then, by gentle traction, the forceps are withdrawn until the pupillary edge of the iris appears well outside the corneal incision. At this moment the folded iris tissue is cut through with one snip of the scissors held exactly in the vertical meridian of the cornea. If this step is properly carried out the margins of the coloboma thus formed will recede within the anterior chamber. If, after waiting a few moments, there is no disposition on the part of the iris to do so, it would be well to replace it, either by gently stroking the cornea with the back of a spoon, or by the employment of the iris-repositor.

Opening or cutting the capsule—cystotomy. The surgeon now takes in his hand the cystotome and introduces the point of the instrument (which should always be quite sharp), with its cutting edge backward into the anterior chamber. Of all the forms of cystotomy that I have made use of the following is preferred: The back of the instrument is directed beneath the iris at the lower end of the vertical meridian. When the point reaches that position it is given a half turn so that the cutting edge is engaged upon the periphery of the anterior capsule. A firm and steady scratch is made, by the withdrawal of the handle of the cystotome, in the direction of one or other margins of the coloboma. The point of the cystotome is now disengaged and again introduced, as in making the first cut, and once more entered at or near the first point of capsular puncture. A second scratch is made, in precisely the same manner, towards the opposite margin of the coloboma. The upper points of these two incisions are now joined by a third scratch with the point of the cystotome which is further extended, until it involves nearly the upper half of the periphery of the capsule. Although this incision seems a complicated one, yet it generally combines the virtues of a partial capsulectomy with forceps and the best form of capsulotomy. Not only does it afford an admirable chance for extruding the lens proper but a portion of the anterior capsule corresponding to the pupil is almost always dislodged with the cataract.

Expulsion of the lens. The delivery of the lens is a very important step in cataract extraction, because most of the ordinary accidents attendant upon the operation occur during this act. The best results in average cases are obtained by the use of two spoons, one placed on the inferior aspect of the globe well below the sclero-corneal junction, and the other laid on the upper margin of the wound behind the incision. The patient is told to look downwards and the lower spoon is pressed firmly and steadily in one spot towards the geometrical center of the globe. It is not well to exert too much pressure upon the posterior lip of the operative wound, although it should be kept slightly depressed below the margin of the oncoming lens. After a little pressure the cataract engages in the incision and by keeping up the same pressure above and below the lens will pass out without difficulty. This is a critical moment and the patient should now be warned to keep on looking down and still to keep hands, mouth and both eyes wide open. As the lens enters well into the wound the lower spoon should gently and steadily follow it and an endeavor should be made to preserve the same relations in distance between the lower edge of the cataract and the margin of the instrument. Wilder advises gentle stroking of the cornea at this moment so as to gather all the cortical substance possible in front of the lower spoon and about the lens and then, with one sweep, deliver the nucleus and cortex together. In this way the maximum amount of soft matter can be removed at the most propitious time.

In dealing with every lens—whether its passage be easy or difficult—one should try to expel it as nearly as possible en masse, avoiding, meanwhile, rupture of the zonula—an accident likely to happen if too much, or undue, force is employed. Some difficulties in the delivery of the lens may also arise from too small a corneal section. This complication occurs with a badly made incision, especially when the deep wound is smaller than the superficial one. It may also arise when a broad flap is made after the extraction of a lens with a hard and large nucleus. Then, again, the capsule may be insufficiently incised, or not opened at all. The surgeon generally discovers this failure when, on pressure, he finds that the lens moves slightly but makes no actual progress towards a complete exit. In that event, a very sharp cystotome should be used a second time.

As mentioned before, the capsule of Morgagnian cataracts is extremely difficult to cut even with a proper capsulotome.

Difficulty is to be expected with very opaque capsules, especially when they present a large, white, dense, circumscribed opaque area. Having been forewarned by these appearances the surgeon should employ a very sharp cystotome, using cautiously a little more force than usual, tearing the capsule if needed.

If vitreous escape in front of the lens and the latter sink backward into the vitreous chamber the best plan is to finish the operation by means of a wire loop or vectis. This procedure does not necessarily increase the vitreous loss. Herbert thinks that rupture below the lens is much less likely to give trouble than when above. In the former instance there is a tendency to displacement of the lens upwards so that depression of the upper margin of the wound is imperative before expulsion is attempted.

As soon as the lens is delivered the speculum should be removed, if this has not already been done. There now remains the removal of all the cortical matter, blood clots, tags of capsule and other debris.

Expulsion or removal of cortical matter. Unfortunately, it is impossible to determine exactly how much of the cataract or its capsule remains within the eye, because portions of these tissues are often invisible. A routine plan, when one suspects from the appearance of the expelled cataract, or for other reasons, that cortical matter is left behind, is, first, to make an attempt at "milking" or gently pressing out (by upward stroking of the cornea) as much as possible of these remains by the use of one or other of the spoons employed during the expulsion of the lens. Then some form of intraocular irrigation is used. Although the regular Lippincott irrigator is occasionally employed, one may be quite satisfied with a glass tube provided with a curved lip about 3 mm. wide and one mm. thick. This is attached to a bulb about 3 inches in diameter. This small instrument can easily be sterilized and is very effective in removing cortical matter, washing out blood clots, capsule tags, etc., from the anterior chamber. It is rarely necessary to introduce the point into the anterior chamber. By carefully depressing the posterior lip of the wound and engaging it barely within the incision a return current can be established on pressing the bulb so that lavage of the chamber may be accomplished almost as well as, and with fewer risks than, attends the Lippincott or other form of intraocular irrigation. Frank Allport has modified the Weeks irrigator by having the glass tip curved so that it can be more easily entered at the angles of the corneal wound.

Whether we wash out the anterior chamber or not, a simple, but at this stage of the operation exceedingly useful, procedure is the removal, by means of a spoon, spatula, iris repositor, or similar instrument, of all the foreign bodies from the wound-angles and along the line of the sclero-corneal incision. The point of the instrument is entered at one angle of the wound and carried to the opposite side.

The whole length of the incision should, finally, be closely examined with a lens for the purpose of detecting and removing any lenticular shreds, pieces of capsule, iridic pigment, vitreous beads, or minute blood-clots, that have escaped the earlier inspection. When even very small tissue shreds are allowed to heal in the wound, they are prone to attach themselves also to the iris, to the posterior capsule, or to floating bodies left in the anterior chamber, and so greatly mar the final result. Not only that, but they establish a communication between the interior of the eye and the outside world, and thus sooner or later become the means of infecting the delicate parts within.

Knapp and others have warned us of the danger which attaches to massage of the cornea with the finger and lid-edges in attempts to remove any of the anterior-chamber contents. The free borders of the lids are the parts of the external ocular apparatus most difficult to sterilize and most crowded with pathogenic microbes. It has again and again been demonstrated bacteriologically that the palpebral edges remain infected long after the surrounding skin has been rendered fairly sterile. The cilia perform for the conjunctiva much the same office that the vibrissæ do for the nasal mucosa, and the number and variety of bacterial colonies planted upon the free borders of the alæ nasi closely resemble those which we find infesting the skin about the eyelashes. Consequently, to rub, ever so lightly, the free edge of the lid over the freshly-made wound in the cornea, is to invite infection of the latter.

If the patient is unreliable there is danger in the employment of any intraocular irrigator.

During this procedure the assistant generally holds the lids apart by means of retractors, although these are not always necessary. The removal of the cortex is of great importance and it is better to run a little risk at the time of the operation than to have to deal with irritative iritis and secondary cataract after the healing of the corneal wound.

Immediate treatment of the sclero-corneal incision and conjunctival flap. The conjunctival flap is now carefully replaced from its position on the cornea and, so far as possible, the lips of the wound are brought well into apposition. All loose débris should be coaxed from between the lips of the wound by means of pencils or "dabs" of moist cotton, assisted by a flow of warm boric acid or normal salt solution from the irrigator. One may supplement these efforts by the use of small iris or other forceps to drag out with due care such cortical and other remains as are not removable by gentler means.

Finally, when all this is done, or previously, the blepharostat should be removed and the lids allowed to close. This last act is best accomplished by drawing the upper lid up, and asking the patient to look down. The upper limb of the speculum is now easily disengaged. Then gently drop the lid upon the globe so that its edge falls well below the conjunctival flap. The lower limb of the blepharostat readily follows as the patient is told to look up.

The patient is now informed that everything is over and there is nothing further to be done except to have a bandage over the eye. At this juncture, it is well to ask the patient whether he would like one or both eyes bandaged, telling him that in any event we wish him to keep them both closed most of the time for the following 24 hours. By making this a matter of the patient's choice it assists him to bear up for an important period following the operation. Moreover, if he is allowed to open his eyes, but knows that it is better to keep them closed, he will probably choose the latter horn of the dilemma and not take much of the liberty extended to him.

The Simple Anterior Chamber Irrigator Ready for Use in the Extraction of Immature Cataract.

Anterior Chamber Irrigator for Use in the Extraction of Immature Cataract.

If it be desired to affect the eye with drugs of any sort, now is the time to use them. It was once almost the universal custom to instill a one per cent. solution of eserine, when the simple operation was chosen, for the obvious purpose of contracting the pupil and so preventing prolapse of the iris. But as neither mydriatics nor myotics have any appreciable effect upon the muscular fibers of the iris so long as the anterior chamber is empty, this procedure has been pretty generally abandoned.

A decided mydriasis may, however, result, just as soon as it is again refilled, from an instillation of atropine, even two or three days before the anterior chamber has reformed. If applied at all, I am much in favor of employing these remedies in the form of ointment, smeared on the lids or on the dressing. Not only is a drug applied in this manner more uniform in its action, but it is decidedly more persistent than when exhibited in solution. Moreover, one also obtains the soothing effects of the greasy application to the lid-edges, preventing their adhesion if much mucus is formed beneath the dressing, and allowing a ready escape for tears and other discharges.

Before removing the patient from the operating table it is well to explain to him what he may expect during the following day or two. Tell the patient that, while you wish him to keep quiet and talk little, he will not have to stay in bed very long; that he may lie either upon his back or upon the side opposite the eye operated on, and that very soon he will be permitted to sit up in a chair. He should be warned against making any sudden movements, cautioned against straining himself in any way, and advised not to touch his eye or allow anything to press against it. Also informed that a nurse will be at hand to answer any question that he may ask, and that he is to go to sleep at the usual hour.

Beard's cautions. In his admirable work on *Ophthalmic Surgery* Beard has appended to his description of cataract extraction a number of negative suggestions and directions under the caption of ''Don'ts.'' Every student of the cataract operation is advised to read and digest them.

''Don't get shaky. Pick up the knife, make a few finger movements with it and, if the hand is turning craven, just call a slight halt, resort to a little inward discipline, and one can usually regain his composure. A colleague once told me that when he found himself becoming demoralized on the eve of an operation, he walked to the window and, while apparently taking in the view, proceeded to give himself, mentally, a sound castigation, with the invariable effect of restoring his calm.

''Don't drop cold or hot liquid into the eye during or after the operation—have it lukewarm. Don't let it fall from a height onto the eye and lids, as all tends to produce wincing. Don't squirt nor fire solutions at the eye, but pour them gently over it, and always warn the patient of your intention. Don't permit sponges to touch the cornea and disturb the epithelium.

''Don't begin the instillation of the cocain solution until it is known that the operation can follow in not more than ten minutes. Don't let the speculum fly out of the fingers like a jack-in-the-box while in the act of putting it in position. Get a good, firm grip on it.

"Don't pry the lids too far apart, for it induces spasm of the orbicularis and increases intraocular tension. Don't allow the speculum to rest heavily upon the globe. Don't fail to lift it away from the eye, and with a firm grasp, in removal.

"Don't use fixation forceps that have a catch, and don't forget the hand that holds the forceps while fixing the eye. Don't rotate the eye with the forceps as if it rested with its posterior surface on a transverse vertical plane, but as it is, like a ball that turns on a universal central pivot.

"Don't seize merely a fold of conjunctiva by which to steady the eye, but in addition, as much as possible of the subjacent tissues and as near as practicable to the cornea. Don't employ fixation after the bulbus is opened unless the need is urgent.

"Don't neglect to test point and edge of both knife and cystotome before they are disinfected, to see that they are sharp. Don't use a knife with long, needle-like point—the tip might break. Don't hold the knife so tightly as to cramp the fingers, nor yet so loosely as to cause wavering. Don't attempt either corneal or capsule incision free hand. No matter how steady the latter, always rest the little finger on the patient's face, not only for support, but in order to move with him should he stir.

"Don't haggle, fuss, nor hesitate in making the section, yet, while forging steadily ahead, do so with a certain deliberateness. Faulty sections, premature escape of aqueous, etc., come not so often of slowness as of vacillation.

"Don't lose sight of the patient's demeanor. If this be favorable throughout the corneal section, it is apt to be so for the entire operation. If he begins to squeeze, pause, even though in the midst of the incision, and remonstrate with him in a kindly tone, and have the assistant guard closely the brow and speculum.

"Don't take the eyes off the site of the operation for an instant. Have the assistants so trained that it will not be necessary for the operator to seek instruments and implements, nor to lay them down. Be in the closest touch with the subject, allowing not a single break in that subtle, intuitive current whereby we anticipate a move on his part.

"Don't crawl all over the capsule and zonule with the cystotome. Take pains to place the point properly on the cataract just where the opening should begin—not hastily; elevate the handle until the point is sure to have engaged the capsule, then draw it very lightly along, making a definite cut, and note that the lens responds to the liberation by springing forward. If not, it is better to go over it a second time, there and then, trying to improve upon the first effort than to be obliged to again enter the instrument.

Don't triturate the cornea too much with the spoon in delivering the cataract, nor rub it about in an aimless sort of way to get out the cortex. Be sure that the back and not the edge of the instrument is applied. Don't stop to pick up the extracted lens unless it is caught deftly upon the upper spoon—merely brush it aside until the operation is terminated.

"Don't have the instruments dripping wet, as the liquid, streaming downward, carries bacteria from the fingers to the eye. Don't hold instruments in the mouth to disembarrass the hands. Give them to an assistant or lay them down.

"Don't talk any more than necessary, and never with explosive aspiration, to emit showers of germs, even though mouth and nose be covered by a mask.

"It is the better part of wisdom to close and bandage the eye as soon as practicable after the extraction of the cataract, and to discourage all unnecessary movement or turning of it. With this in view, little exhibitions like having the patient count the operator's fingers or to tell the time on a watch, through a convex lens, it is deemed prudent to omit. Such things were formerly supposed to be a test as to whether any portions of the cataract were left behind, but as such the performance is a delusion."

I have never been able to understand what possible good can be secured by a firm pressure bandage of any sort after cataract extraction. Most patients, it is true, feel more comfortable if there is slight but even pressure upon the exterior of the lids, but the use of a bandage with the idea of securing fixation of the eye is, to my mind, not feasible. I quite agree with Jackson (*Ophthalmic Review*, November, 1907), that we should avoid the extremes of no protection at all to the eye, and too heavy or too much bandage. That writer draws attention to the fact that in the normal eye the sclero-corneal coat is distended by the intraocular pressure, and that the corneal section for cataract extraction reduces this intraocular tension to zero. The relations which the two lips of the wound take to each other in healing are determined during this period. The incisions usually practised cut the sclero-corneal coat more or less obliquely. Since the intraocular pressure after extraction is zero, the external pressure must be excessive; even the weight of the lids resting passively upon the eyeball forces together the oblique lips of the wound and produces over-riding of the anterior or upper lip.

The important, practical deduction from this theoretical consideration of the relation of the lips of the cataract incision is that pressure upon the eyeball should be carefully avoided after cataract extraction. Even harmful pressure cannot secure, or greatly assist, fixation of the eyeball. But very moderate pressure can be harmful by causing such displacement of the flap as will interfere with smooth healing. Fixation of the eye and rest of the parts are favored by closure of the fellow eye and guarding against startling the patient by sudden noises. A dressing in light contact with the lids keeps them closed and favors quiet of the eye by reflex influence. But the bandage, which cannot retain its position unless it makes some pressure, should be discarded after cataract extraction.

Post-operative dressings in cataract extraction. For a full exposé of this subject the reader is referenced to the **After-treatment of ophthalmic operations,** but it may in addition be said that simpler the application the better. This assertion is made because the patient's comfort from this time on is a sine qua non and those applications that are comfortable to him, that permit him to sleep, and that do not require too frequent removal are generally to be desired.

The so-called "triangular" bandage is the one the writer has used as an immediate post-operative dressing for many years. It is made by placing a thin, uniform layer of sterile cotton wool between two thicknesses of gauze and then cutting the three layers into a circle which slightly overlaps the orbital margins. Before applying this covering to the eye the lower lid is drawn down and a very small quantity of White's ointment is introduced into the sulcus. This serves to keep the lids from adhering and acts as a mild antiseptic.

Place the circular dressing, previously smoothed out, upon the eye. Two strips of adhesive plaster (made with zinc oxide so as not to irritate the skin) are attached along the eyebrow and nose; a third piece at the outer margin of the orbit completes the triangle. This bandage is light, porous and eminently satisfactory. It never gets out of place and does not unduly press upon the eyeball.

Removal of the patient to his room. When the extraction is done in the operating room, in the presence of the patient warn the orderlies or hospital assistants to be careful in lifting him from the operating table to the stretcher and to avoid collisions with walls and doors in the transit to his room. Either the nurse in charge or a house surgeon is expected to attend the patient on this journey, and to see that he is comfortably placed in bed. It would be well if the surgeon were also to visit the patient before leaving the hospital.

The writer is not in favor of keeping cataract patients in a dark room. Allow a certain amount of light to enter and permit the use of a lamp provided with a proper shade.

It is generally advisable to prescribe an old-fashioned mixture containing 1.50 grammes of potassium bromide with 0.5 gramme of chloral hydrate half an hour before the time the patient usually goes to sleep. The interne should be warned as to the possibility of vesical retention and should inquire into the condition of the bladder while making his evening rounds.

Shields and masks as protectives after cataract extraction. What can be more provoking to the surgeon than to find, after obtaining a good operative result, that a careless nurse or a restless patient has added a newly-opened corneal wound, a hernia of the iris, or loss of vitreous, to his other anxieties? A finger-thrust, a pillow-end jammed into the eye, a slight blow upon the globe, or any other of the dozen little accidents that happen to a person with imperfect vision moving about in darkened rooms, may nullify the most brilliant and correct efforts of the operator. Especially when night comes on, or when the patient begins to move about, the eye should be protected from injury by some sort of shield or mask. Fuchs uses the woven-wire protector introduced as long ago as 1883. There are many modifications of this mask in the market, one of the best of which is the "base-ball" mask suggested by Würdemann.

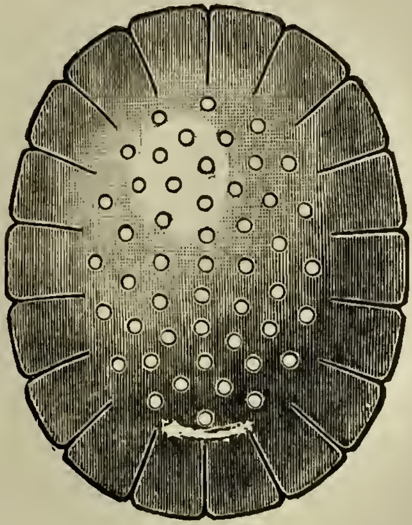
Certain operators who make use of the roller bandage gain protection by starching the dressing. When this has dried, the eye will receive a considerable blow without injury.

Snellen has used a turtle-shaped aluminum shield, about ten centimeters long and five wide, placed over the eye and held in position with strips of adhesive plaster; it forms an admirable protector.

Although I have for many years used Ring's papier-maché mask (q. v.) yet, lately, have employed and find great satisfaction in applying over the cataract dressing a modified form of Snellen's aluminum disk devised by Webster Fox. It is firm, pliable enough to be adapted to any orbital region, well ventilated and can be easily kept in place by a few adhesive strips. The latter method of fixation is preferred to the tapes for which it was originally adapted. (See the figure.)

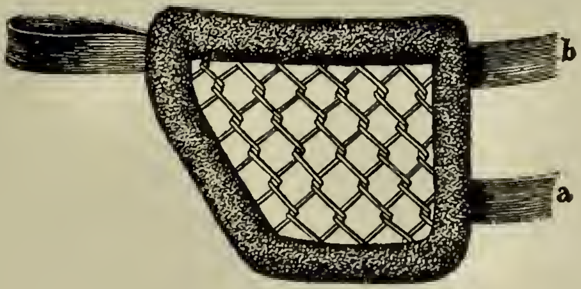
A somewhat similar protective shield, slightly modified from the Murdoch model, has been recommended by Theobald. It also is intended to be kept in position by three strips of adhesive plaster and seems to be well adapted for the purpose of preventing post-operative accidents.

A small proportion of patients object to wearing any sort of mask, claiming that it prevents them from sleeping and makes them nervous. In such cases one may get along very well with a large, stiff and very concave eye-shade placed over the dressing and held with a piece of rubber plaster.



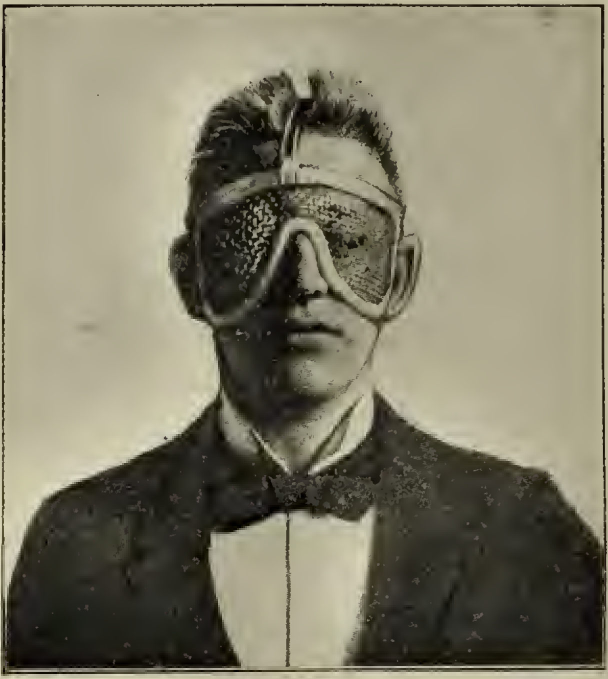
Fox's Modification of the Snellen Aluminum Cataract Shield.
This protective is well ventilated, light, easily adapted to the patient's orbital margin and readily kept in place by adhesive straps.

It is better to always remove the bandage and look at the eye twenty-four hours after the extraction. The corneal wound is now either altogether healed over, especially if a conjunctival flap has been made, or if not the danger of prolapse of the iris has generally passed. That is to say, if no iridic hernia has occurred at the end of twenty-four hours, it is not likely to happen at all from any cause, except from violent sneezing, coughing, direct traumatism, etc. In cases of uncomplicated cataract removal the lids at the end of twenty-four hours are not discolored or edematous. From a glance at them, one can generally predict the condition of the eye beneath. The discharge on the band-



Fuchs' Wire Cataract Shield.

age should be watery only (or contain little mucus) and ought not to be copious. The main object, however, of the inspection is to determine the position of the iris. If prolapse has occurred, now is the best time to deal with it.



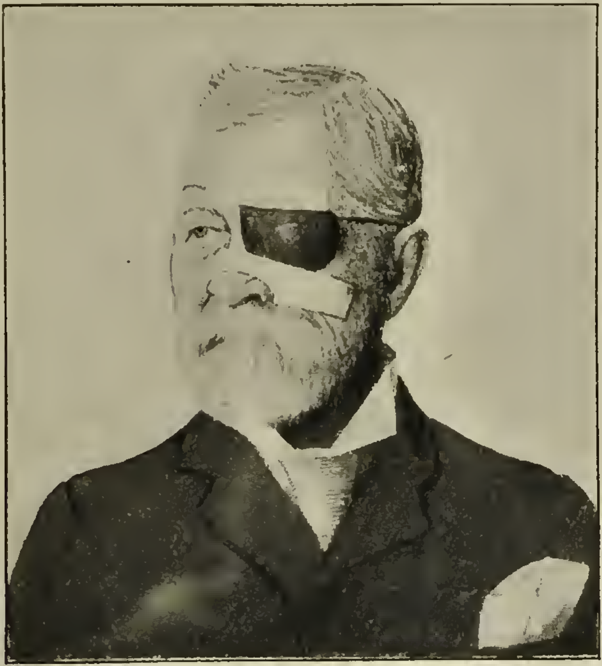
Würdemann Base-ball Cataract Shield.

The eye should be gently bathed with boric acid solution, and any mucus, vaselin or ointment washed off the lids and cilia. This should be repeated daily. Solutions instilled into the eye must be neutral or slightly alkaline to test-paper, and always warmed.

When the corneal wound is healed and the anterior chamber re-established, the ordinary bandage may be dispensed with, substituting for it a concave monocular eye-shade which, while touching the brow, cheek, and nose, is clear of the eyelashes. This is worn loosely over the eye during the day, and at night is kept in place by a small strip of adhesive plaster (as shown in the figure). In a week or ten days one may usually dispense with any dressing or protection whatever, particularly where the patient remains indoors.

The period of confinement of the patient. On what day should the patient be allowed out of bed? In all ordinary cases twenty-four hours is long enough for him to maintain absolute rest. Still avoiding sudden movements, he may then be allowed to sit up in an arm-chair and even to move about in the room, and so gradually regain his wonted liberty.

The writer's experience has been well confirmed by Roune who has observed in many cataract patients that a few days after operation general symptoms suggesting gastric disturbance, such as furred tongue, sour breath and anorexia, occur. This state is usually accompanied by ocular symptoms: congestion of the conjunctiva, contraction of the pupil and a tendency to the formation of synechiæ. The patients affected in this way were all decidedly arthritic.



Concave Shield for Protecting the Eye After Cataract Extraction.

The condition did not yield to rational treatment, but the symptoms disappeared in a few hours when the patients were allowed to get up. He thinks, therefore, that there must be another factor than digestive troubles to account for this autointoxication. The patients who presented these symptoms most decidedly were those who, from fear of making any movement, subjected themselves to an exaggerated immobility, and then were usually pronounced arthritic subjects, who have special need of exercise and in whom absolute rest favors the production of toxins.

Experience has shown that it is unnecessary to impose upon a cataract patient a prolonged repose, and the author allows his patients to get up in 24 or 48 hours, and uncovers the other eye the day after the operation.

After 48 hours the bowels should be moved by an enema, when more solid food may generally with advantage be added to the dietary.

Common sense will dictate when and under what circumstances the subject of cataract extraction should venture out of doors. If exercise be taken in a close carriage, he may, with the eye wearing an ordinary shade, be allowed out, even in severe weather, as early as the end of the second week; when the day is comfortably warm and there is no wind blowing, walks may be taken with impunity.

There should be absolutely no use of the eyes for a month, when glasses should be allowed for distance. As soon as the patient is accustomed to these, lenses for near work may be prescribed.

VARIOUS PROCEDURES AND MODIFICATIONS.

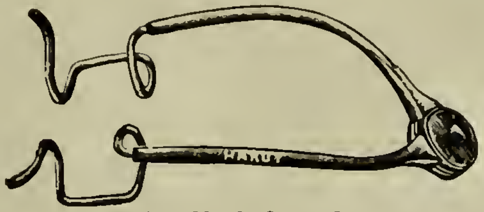
The modifications of the usual instruments employed in the modern operation of cataract removal are quite numerous.

Testing instruments. Priestly Smith has invented a balance for testing the sharpness of cutting instruments that is described elsewhere. Any device that assists in accomplishing those necessary desiderata, viz., clean, polished and very sharp knives, lances, scissors and needles, is devoutly to be wished. It may not take the place of a magnifying glass and the ordinary kid drumhead but may at least be used in conjunction with them. It is just as essential that the operator know whether the cutting instrument he is about to use is sharp as that it is clean.

The speculum and blepharostat. Some device—the simpler in form the better—is generally employed to separate the lids during the operation, or until the corneal section is completed. For many years the writer has used the gold-plated Clark speculum, made by Weiss, of London. Not liking the ''stop'' or catch attached to most of these instruments, that appendage has been removed and the result is a strong but light, easily adjusted blepharostat whose spring maintains for years just enough force to increase the interpalpebral space to the utmost without pain or even discomfort to the patient. The absence of the stop enables the operator to remove the instrument in an instant and at a moment's notice.

It was Sharp who first (in 1753) pointed out the probable value of the blepharostat. ''I should not be surprised,'' he said, ''if the use of a speculum oculi should hereafter be esteemed an improvement. But, then, it must be contrived so that it shall not compress the globe of the eye; or, if it does, the operator must be careful to remove it in the instant the incision is making, lest by continuing the pressure after the wound is made, all the humors should suddenly gush out.''

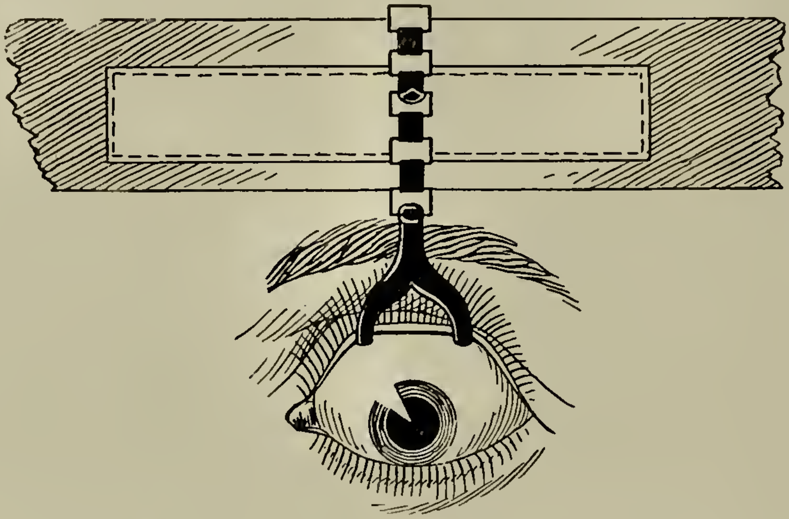
As often pointed out in discussing the subject, many an eye has been lost because the patient has attempted to close the lids after the corneal section and while the speculum was still in place; for the lens may be forced out, followed by a serious loss of vitreous. Some of our most skilful and experienced operators have entirely done away with the use of the speculum for this reason, and in its place use the thumb and fingers to keep the lids open, or they have a trained assistant do this, or use a lid elevator. But not all operators can have such an assistant and at all times. Others remove the speculum as soon as the corneal section is finished and the capsule opened.



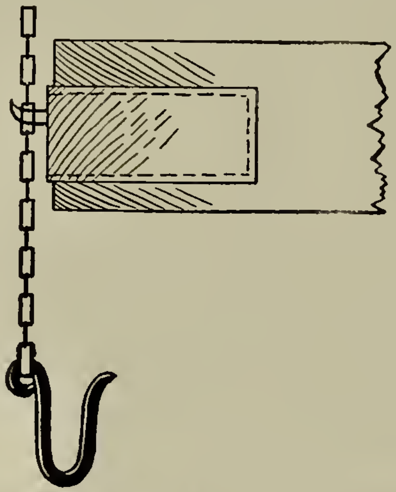
The Clark Speculum.

To avoid this source of danger as far as possible and not use any speculum, Swasey (*Jour. Amer. Med. Assoc.*, Nov. 16, 1907.) has devised a form of lid elevator, shown in the accompanying illustrations. It is a lid elevator, minus the handle, and in place of this he has used a small linked chain, which easily molds itself to the curve from the eye to the small shallow hook on the silver plate, attached to the band passing around the head. The hook of the lid elevator is the same size as the one shown in the illustration and has the same curve. A more shallow hook is liable to turn out from under the lid if any considerable pressure were put on it. After this hook is in place the patient is asked to try and shut the eye, to make sure that it will stay in place. Should it come out, it is reintroduced and the lid lifted one or two links more on the chain—as much as the patient can stand comfortably. Under these conditions this form of hook in Swasey's hands has never failed to hold securely. The eyeball is now well exposed, and the field of operation is unobstructed. Should the patient attempt to close the lids, the force of the pressure is not on the globe, but must be at the point of anchorage—the hook on the head band.

Fixation instruments. There are numerous instruments for keeping the eye quiet and in position, but whatever form they may take they should have stout but not too heavy blades. The latter ought not to be too long, and they should be without a catch. The spring of the forceps ought not to be too strong, else it will tire the fingers of the operator or assistant. Above all, while the teeth should be sufficiently sharp to grasp the tissues they should not be needle-pointed, as they often are, otherwise they will cut through the conjunctiva and make a nasty wound. There ought to be three teeth in one blade and two in the other, and one set should fit accurately into the other. As a rule, these instruments are made too long and really embarrass the operator; it is not necessary that the handle of the forceps should project several inches above the hand that holds it.



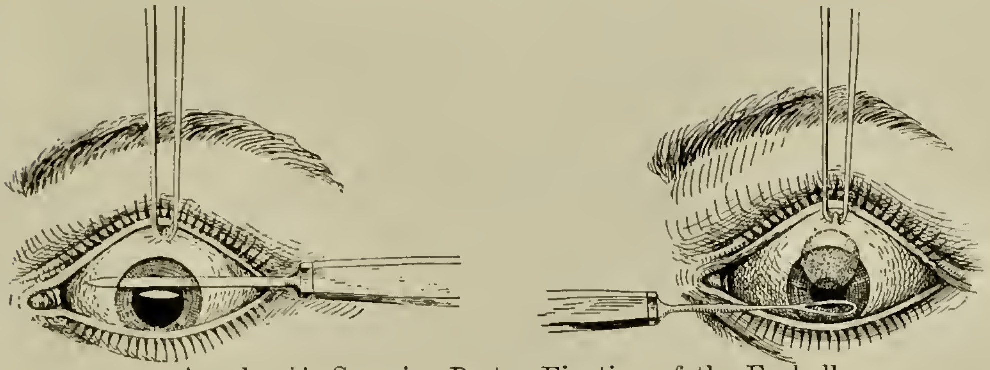
Front View of Swasey's Lid Elevator, showing Method of Use.



Side View of Swasey's Lid Elevator.

Prince advocates the use of a lid elevator which is composed of two fenestrated loops, one of which passes under the lid and the other rests on the sclera and serves to make pressure on the upper flap of the wound. Counterpressure is made below with a spoon in the usual manner. His fixation forceps are claw-like, each blade terminating in a sharp, single claw, as shown in the cut, which buries itself in the sclera, but does not entirely penetrate it.

The Angelucci fixation method. This surgeon (Una Modificazione al processo di Estrazione semplificata della Cataratta. *Archivio di Ottalm.*, Vol. V, fasc 3-4, p. 6.) rotates the eyeball downwards and seizes with strong fixation forceps the tendon (with the overlying structures) of the superior rectus. By this means the globe is not only perfectly fixed but the upper lid is held out of the way. In sunken eyeballs, or when the patient attempts to squeeze the lids together or to rotate the eyeball upwards, these efforts do not cause gaping of the wound. Moreover, the grasp of the forceps can be loosened in an instant at any critical moment during the operation and the lids closed at once. This method is very useful in several forms of cataract and is extensively employed. It is illustrated in the text by drawings from the author's original paper.



Angelucci's Superior Rectus Fixation of the Eyeball.

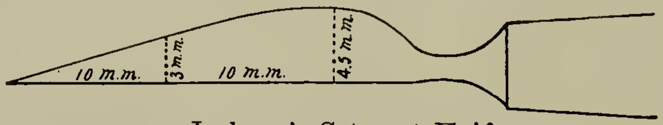
During the corneal incision. During delivery of the lens.

The corneal knife. In the ordinary operation the well known Graefe knife is employed. Although many operators prefer aluminum or steel handles the writer favors of ivory. The last-named material is not too heavy, does not get slippery when wet and stands various sterilizing processes quite as well as metal. Nickel-plated handles in particular become rough and soon lose their polish. The blade of the Graefe knife should have a well sharpened, almost needle-like point and should not be too broad or too long. For the average cataract extraction medium-sized knives are preferred, although there is considerable variation in the choice of these instruments among ophthalmic surgeons.

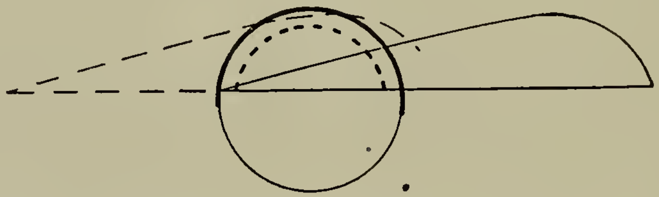
Edward Jackson, in the hope of discovering a knife that would combine all the advantages of Beer's instrument—single, forward thrust, smooth incision without angles, and no intermission in the corneal resistance—devised the knife pictured herewith.

It is an improvement on a former instrument, a description of which was published in 1888. The inventor describes it as follows:

"The essential characteristics of the knife now presented are: The blade has a maximum width barely sufficient to complete the desired corneal section. The maximum width is reached 20 mm. from the point. At 10 mm. from the point fully two-thirds of this maximum width is reached. From the point to the 10 mm. line the edge of the knife is straight. From the 10 mm. line it begins to curve, so that at the 20 mm. line the edge is parallel to the back. The back is straight throughout. The blade is flat and is as thin as is compatible with sufficient rigidity and strength. Its outline is shown in the figure; the dotted lines indicate distances of 10 mm. from the point.



Jackson's Cataract Knife.



Jackson's Cataract Knife; Showing the form of the section.

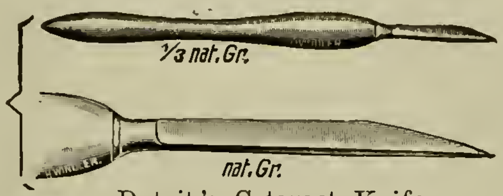
"The particular width of the knife must be determined by the depth of the corneal section it is desired to make. The dimensions given in the figure are for nearly the maximum corneal flap of 4.5 to 5 mm. For a 3 mm. flap the maximum width of blade should be 3 mm. or a little less, and the width at 10 mm. from the point should be 2 mm.

By holding such a knife with its widest part in front of the cornea with its cutting edge opposite the corneal margin, where the center of the incision is to come, the back will indicate quite accurately the points for the puncture and counter-puncture.

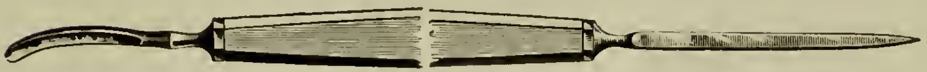
The knife is to be entered at the point for the puncture with its blade in the plane of the proposed section, and its straight back pointing toward the point for the counter-puncture, and then pushed steadily forward. In the illustration the solid routine represents the position of the knife at the completion of the counter-puncture. The boundaries of the corneal section are shown by the heavy lines, the section of the external surface by the solid line, and of the internal surface by the broken line.

The back of the knife, by its counter-pressure, so balances the pressure of the cutting edge that there results only a slight tendency of the eyeball to rotate. This tendency is to turn in the direction of the forward thrust. It is best met by placing the fixation forceps just outside the limbus, close below the counter-puncture.

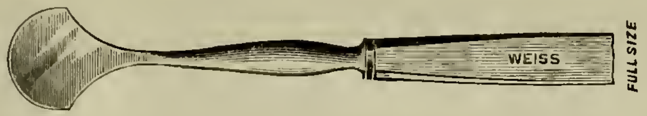
"The forward thrust of the knife is continued until the section is completed, or until the widest part of the blade has fairly entered the cornea. If the section made is a smaller one than the knife is capable of cutting, it will be finished before the widest part of the knife has quite entered the cornea. If it be deeper than the maximum width of the knife, the end of the forward thrust, indicated by the broken line in the figure, leaves a thin bridge of tissue undivided. This is best divided as the knife is withdrawn, by rocking the knife about the point of puncture so as to complete the section with the part of the cutting edge near the point."



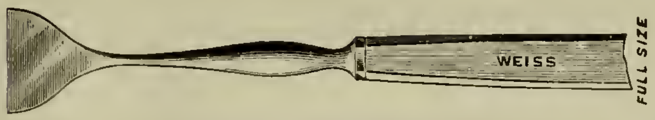
Dutoit's Cataract Knife.



Pope's Cataract Knife, Combined with Shell Spoon.



Hall's Cataract Knife, with Semi-circular Blade.

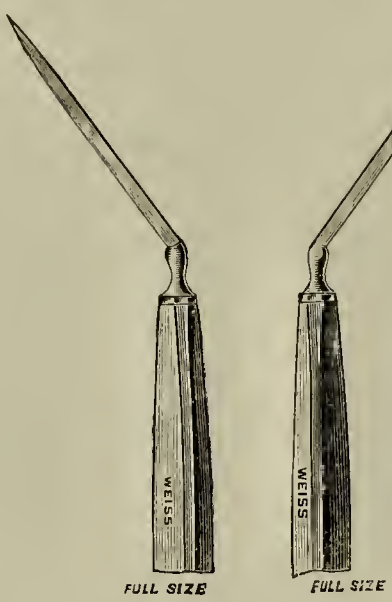


Hall's Cataract Knife (Linear).

Dutoit has devised a special knife (*Zeitschr. f. Augenheilk.*, July, 1911) for his (Zweizügig) double-flap cataract operation.

Several other types are also pictured in the text. These varieties are sufficiently indicated by their legends.

F. Best (*Klin. Mon. f. Augenheilk.*, May, 1913, p. 689) and Weill (*Klin. Mon. f. Augenheilk.*, Jan., 1913, p. 1), regard as a disadvantage the formation of a conjunctival flap with the Graefe knife which, they think, retards the closure of the wound. They consider the section with the lance-shaped knife as the ideal for any operation which opens the eyeball. For obtaining a larger incision, without being obliged to finish it with the scissors, they prefer a lance-knife with an apex angle of 60° and a total angle of the edges of 75°. The section with this broad lance-shaped knife gapes much less than that with von Graefe's knife. The extraction of the lens consumes more time, but the duration of healing is, according to Best, much abbreviated.



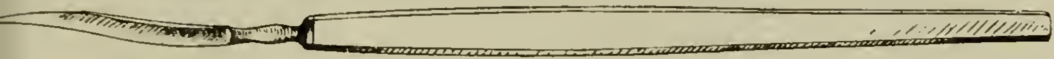
Bader's Cataract Knives (Linear, Right and Left).

These knives are constructed to enable the operator to make an upward incision, commencing on the inner margin of the cornea, whilst standing behind the patient.

Taylor's Angular Cataract Knife.

Bader's Angular, Linear Cataract Knife.

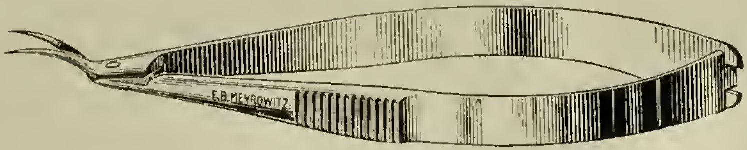
A *creese-shaped cataract knife*, supposed to possess the virtues of easy penetration characteristic of the Malay kris (dagger or sword) is also pictured. It was introduced by Kuhnt.



Kris (Creese)-shaped Cataract Knife. (Kuhnt.)

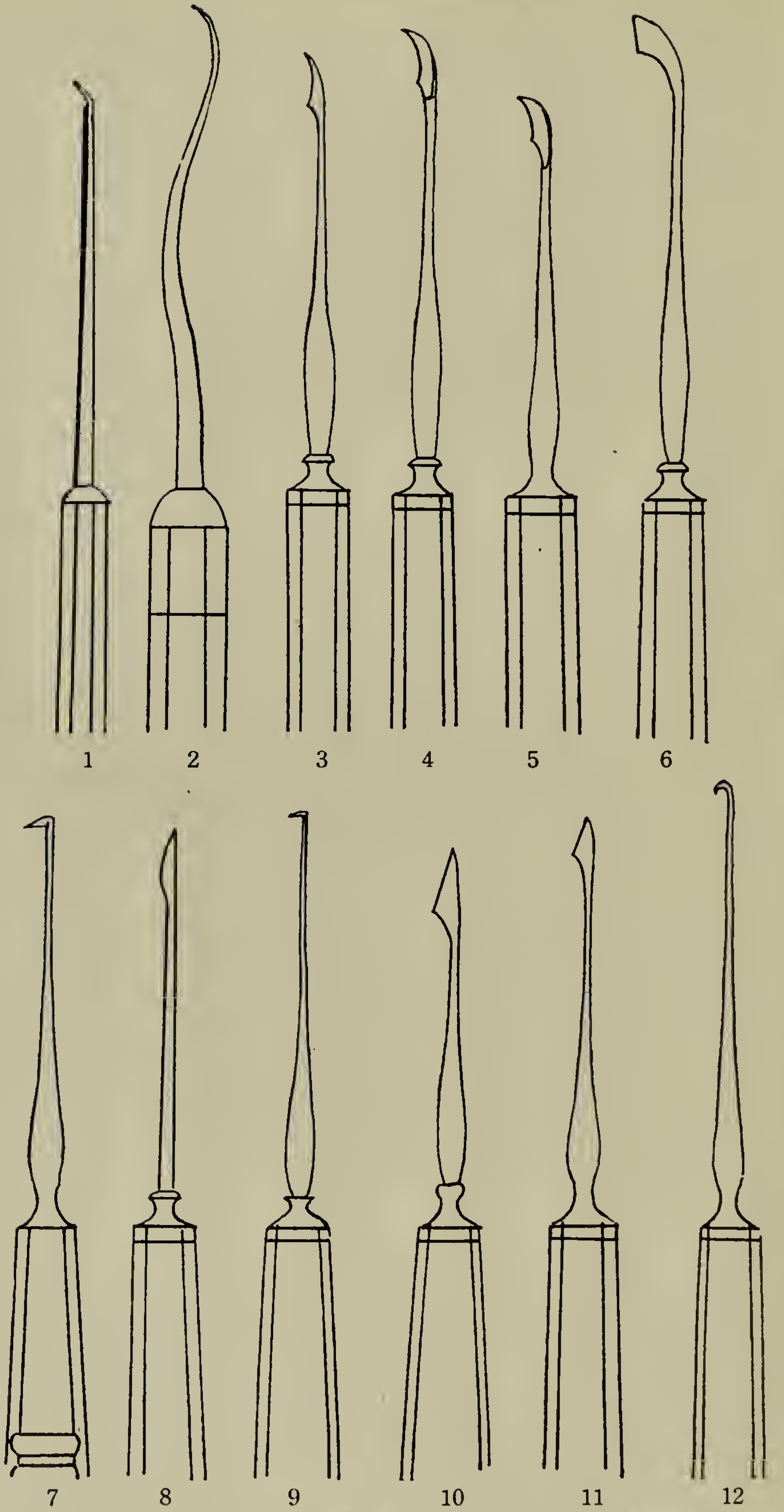
The iris forceps. There are great variations in this instrument, the Noyes pattern being a favorite. It is an instrument easily handled, is small enough to be retained between the thumb and index finger, and is more readily manipulated than long-handled forceps. The writer is tempted to repeat in regard to iris forceps what has already been said about the handles of the fixation forceps; I do not see the purpose of having long handles in either case. They usually get in the way and subserve no useful purpose that one is able to discover. In any event the teeth—one male and two female—should fit quite accurately and they should be sharp and polished.

The iris scissors. Although quite a few operators, perhaps the majority of the better known ophthalmic surgeons, prefer to cut the iris with de Wecker scissors, I have never seen the advantage of that instrument, for this purpose at least, over the common form of half-curved iris scissors. Some operators use a pair of "elbowed" scissors for the right eye and straight scissors for the left, but I have been able to perform the operation using the same semi-curved (on the flat) instrument for each eye. Iris scissors should be well made, quite sharp, and be able to cut easily and as well at their points as anywhere along the blades.

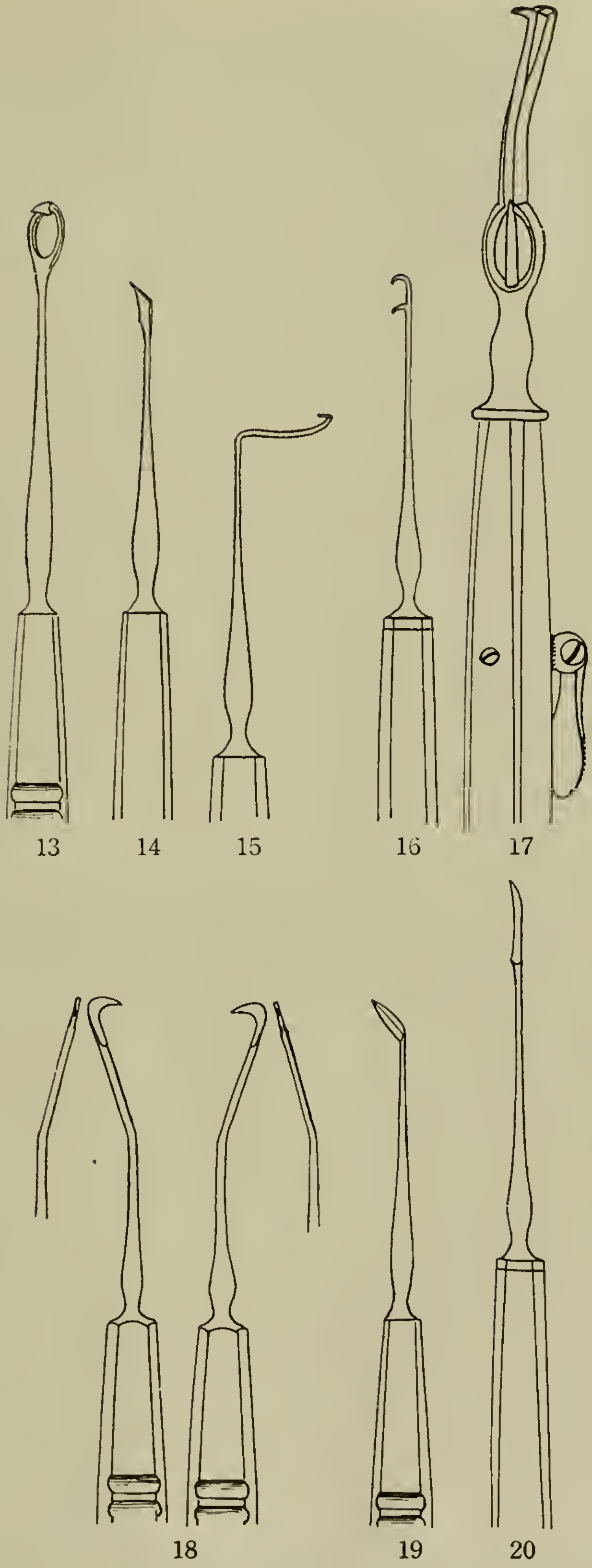


Theobald's Reverse-curve Iridectomy Scissors.

Theobald has devised what he calls his reverse-curve iridectomy scissors (see the figure) which enables the operator to apply the concave surface of the blades—not their convexity, as is necessary with the ordinary curved iris scissors—to the convexity of the corneal limbus, whereby a better mechanical effect is obtained, and a cleaner, more perfect coloboma secured. It is further explained that the scissors are intended especially for the removal of a piece of iris by a single cut—as should always be done in cataract extraction—and are not well adapted to making a large coloboma by successive snips.

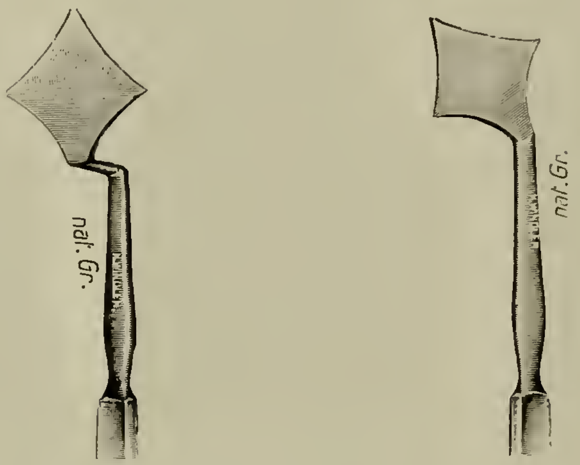


Cystotomes as used by: 1, Freytag; 2, Baron Wenzel; 3, Langenbeck; 4, Rosas; 5, Boyer; 6, Ritterich; 7, von Graefe; 8, Wardrop; 9, Arlt; 10, Desmarres; 11, Cusco; 12, Becker.



Cystotomes as used by: 13, Bettremieux; 14, Knapp; 15, Jaeger; 16, Weber; 17, Meyer; 18, Landolt, right and left; 19, Ziegler; 20, Galezowsky.

Cystotome. Of the dozens of instruments used for the purpose of opening the capsule, perhaps the most satisfactory is the Graefe model, taking care that the point is quite prominent and as sharp as a needle. It is well to have a different cystotome for each eye and that the shank be not bent too frequently in an attempt to adapt it to the various conditions met with. When bent at an angle of about 25 degrees it will be found quite adequate for all ordinary eyes.



Best's Lance-shaped Keratome for Cataract Incision.

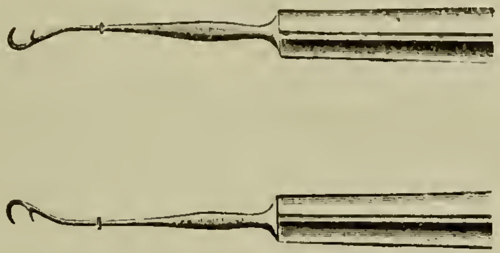
Webster Fox describes twenty samples of this instrument without, by any means, completing the list. They are pictured herewith.

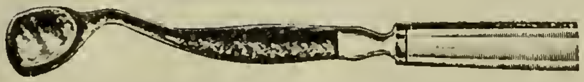
Iris spatula or repositor. For stroking the cornea or for direct replacement of the iris the flat side of a Daviel spoon may be used, although in replacing the columns of a coloboma the flat iris-repositor is perhaps better. When used for reposition of the iris the spoon should have a shallow, concave surface and its edges should be round and thick, while the body of the instrument should not be too broad. In this form it is an extremely useful instrument not only for replacing the iris but in using counter-pressure above the wound in conjunction with the Bowman spoon before referred to.

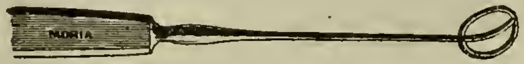
The extraction of the lens is occasionally facilitated by the use of *hooks, crochets* and *spoons* introduced into its substance, so that it may be dragged or pulled through the corneal opening. Several of these are pictured in the text.

Instruments for assisting the delivery of the lens. Spoons of the type of Critchett or Bowman are excellent for this purpose. Modifications, as well as variations from this form of spoon are numerous and will be found considered under **Instruments, Ophthalmic.**

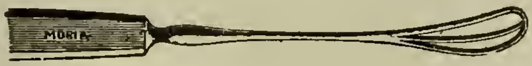
Anterior chamber irrigator. The instrument commonly employed is made of a small glass tube bent 3 or 4 mm. from its point to an angle of 25 degrees and provided with a mouth two or three mm. broad and a half mm. wide. This tube, about three inches long, is inserted and firmly tied to a rubber bulb holding about four ounces of fluid. The whole instrument is rigorously sterilized and cleansed immediately before using. It is carefully searched for the presence in the tube or bulb of rubber dust by ejecting some of its contents prior to irrigation. On some occasions the Lippincott irrigator will be found a very handy instrument.


Weber's (Double) Right and Left Cataract Extraction Hooks.

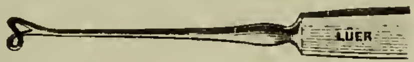

Weber's Cataract Spoon (Made of Shell).



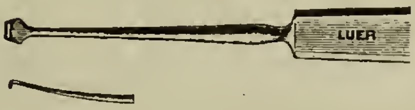
Taylor-Milée Wire Cataract Loop. Round Form.



Weber-Milée Wire Loop. Ovoid Form.



Graefe's Cataract Extractor.



Vacher's Cataract Extractor.

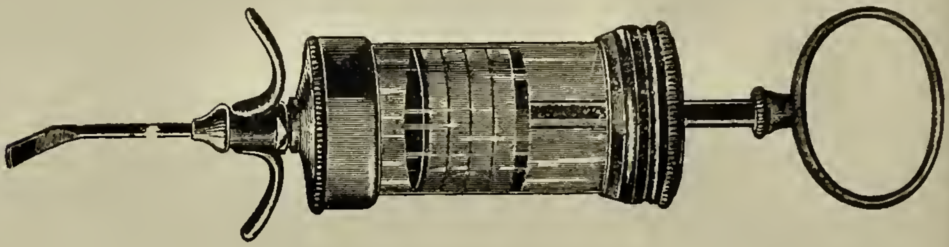
If resorted to at all, the greatest care and gentleness should be exercised in irrigating the eye after cataract extraction. Panas—who, by the way, abandoned the method which he was among the first to advocate—advised the use of a specially devised syringe, the point of which is to be introduced between the lips of the wound, and the anterior chamber flushed with one of the following solutions, which are to be warm:

Borax,	gm.	4.
Boric acid,	gm.	3.5.
Hot sterile water,	gm.	100.

Or,

Common salt,	gm.	1.
Sterilized warm water,	gm.	100.

Instead of using the syringe piston or bulb as the propelling force, careful flushing of the anterior chamber not only with the simple irrigator pictured in the text, but with the following apparatus, is sometimes preferable: A pint bottle filled with the warmed irrigating fluid, and provided with a nozzle and stopcock at its bottom, is placed about four inches above the patient's head. Rubber tubing connects the bottle with the point of a Bowman's syringe. After the whole apparatus has been carefully cleaned of dust and sterilized, the syringe-point is placed within one angle of the operation wound, and the chamber is washed out by a stream from the bottle. The process is repeated at the outer wound-angle until the pupil becomes black and the chamber clear and the iris coloboma edges are in place. The irrigating stream and the syringe point generally act as an iridic repositor.

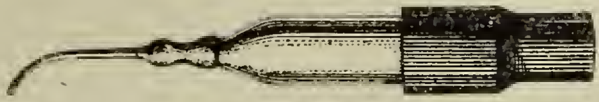


Panas' Syringe for Irrigation of the Anterior Chamber in Cataract Extraction.

Modern variations in the technique and instruments employed in the extraction of cataract. It will, of course, be impossible to even mention all the numerous variants of the ordinary operation for the extraction of the opaque lens, but it is important in a work like this, that the principal modern methods and most of the special instruments employed in carrying them out should be indicated.

Modifications of the corneal section. These have already been referred to but there still remains something to be said on the subject. Daviel, towards the end of his career, made trial of a triangular corneal section outwards, which is described by Czermak, and pictured in the previous text of this heading. The flap was divided into two parts, the first incision being made by an angular scalpel, the second with scissors. The incisions began at the outer margin of the cornea, one of them running upward and the other extending below, both touching the vertical meridian.

It is not possible to complete the sclero-corneal incision in one double movement of the blade without using too much force, especially in sunken eyes and in those with an unusually small interpalpebral aperture. When, however, it can be done, an incision by the smallest number of to-and-fro strokes is most likely to result in perfectly smooth and level wound surfaces that are more apt to unite firmly and evenly than are the edges of an uneven wound. Yet, it must be remembered that the degree of force necessary to complete the incision in a few moments may endanger a weak zonula, especially if a broad knife be used.



Anterior Chamber Irrigator Made from Bowman's Suction Syringe.

The modern section downward. Every now and then a surgeon of experience advocates the making of a section directed downward. Schweigger (Simple Extraction Downward, *Archives of Ophthal.*, Vol. 28, 3, 1898, p. 255), for example, advised this form of operation on the ground that the wound closes sooner and more perfectly than in the usual incision upwards. He used his (double) harpoon for the globar fixation, capsular forceps (when there was capsular thickening) and sometimes made an opening in the iris parallel to its insertion and near the limbus. Tropococaine was used to anesthetize the iris after the section. It was then pulled forward with fine forceps and punctured with a suitable knife. The puncture was afterwards widened with a broad needle. This opening served the purpose of a safety-valve in drawing off aqueous and débris and then closed (as a rule) with the healing of the corneal incision. He thinks that in following this plan vitreous loss and iris prolapse are capable of reduction to the minimum.

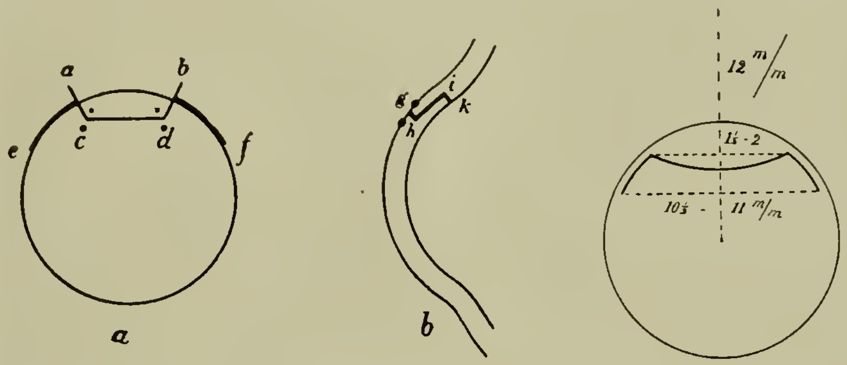
Galezowski made use of a pointed knife in the performance of Graefe's linear extraction, which he did in the sclera outwards. In the same way McNamara, Andrew and Castarina made similar sections at the temporal margin of the cornea with a broad keratome and removed the lens, with a spoon, in its unruptured capsule. Castarina did the same operation, using a Beer's knife.

Bourgeois made use of a double knife-needle whose 1 mm. broad blades are parallel and in the same plane. The needles are locked by a simple mechanism which permits of their easy separation. With this instrument he makes simple extractions by a temporal, lateral section in cases where the application of sutures is indicated, where the palpebral aperture is small, in very prominent eyes and in totally deaf patients. After cocainizing the eye the globe is fixed at one side, the ophthalmostat being held by an assistant. The puncture is then made at the sclero-corneal junction, one blade at either side of the horizontal corneal meridian, the knife being held in the right hand for either eye. At the moment of making the puncture the surgeon himself assumes the forceps with his left hand but gives it to the assistant immediately afterwards. As soon as the blades have penetrated well into the anterior chamber they are unlocked, the lower blade is held in position with one hand while the other is made to cut upwards along the corneal margin nearly to the vertical meridian. It is now withdrawn and a similar but downward incision is made with the other blade. In this way two half sections are made supported by a bridge of undivided cornea 1 mm. broad. The bridge of uncut cornea is now divided with a blunt-pointed knife, and the lens extracted in the usual way. Bourgeois suggests that the lens may be removed in its capsule after a preliminary division of the pupillary margin of the iris with scissors. The sutures are then drawn tight and tied. They are left for five or six days. If necessary, to prevent prolapse or loss of vitreous, a third suture may be placed in the middle of the wound.

Müller's corneal incision. L. Müller also designed a corneal section to be used where the application of sutures seems necessary to guard against prolapse of the iris, or where there is reason to expect loss of vitreous. He first forms at the limbus a small superficial corneal flap with its base forwards. It measures 5 mm. from side to side and extends vertically about 2 mm. This incision is made by entering a narrow Graefe knife into the substance of the cornea, with its cutting edge downwards and without penetrating deep enough to enter the anterior chamber. The incision is now made downwards about 2 mm., when the edge of the blade is turned directly forwards. As will be seen in the illustration, this maneuver makes a small flap, a, c, d, b, which is not thin at its extremity, but is cut at right angles.

Two sutures are now inserted at the angle of the blade, e and d, the loops being left quite loose. The section is now completed by an incision upwards, as in the usual 3 mm. section. After the extraction of the cataract the sutures are tied and left in position for one or two days. It would seem from a description of this method that the intricacies of the technique outweigh any possible advantage to be gained by the operation.

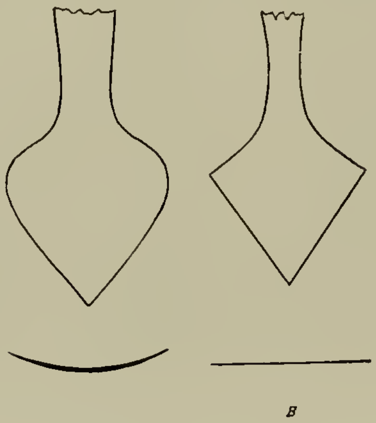
Schulek's incision. A method has been described by Schulek that closely resembles a later double flap section invented by Plehn. Both these procedures are intended to prevent prolapse of the iris. Schulek used a narrow Graefe knife; Plehn a specially made trapezoid instrument. After making the usual upward incision in the limbus for a portion of the distance, the section is completed at an angle downwards and forwards. As a result of this incision, there is in addition to a large lower flap directed upwards a smaller, overlapping portion of the cornea projecting downwards. The lower flap is supposed to fit into the groove behind the upper and to be kept in place by it. It cannot be said that this complicated section has found many friends.



Senile Cataract Extraction.
L. Müller's Corneal Incision. Schulek's Corneal Incision.

Extraction with a lance-shaped knife. J. H. Claiborne employs a keratome-like knife, after the plan of Daviel and Weber. However, this operator's knife differs somewhat from that of his illustrious predecessors. Weber's knife is heart-shaped and has a hollow back. Claiborne's instrument is triangular and has a flat back, so that the anterior and posterior surfaces occupy parallel planes—it, therefore, makes a straight wound—increases in thickness gradually from apex to base, and the handle rises from the base of the triangle exactly as in the regular lance-shaped keratome at present in use for iridectomy.

The length of the Weber knife is 10.25 mm., the one Claiborne describes is 8 mm. in length. The greatest breadth of Weber's knife is 12 mm. at the base of the triangle; Claiborne's also measures 12 mm. at the base. Weber's knife was so constructed that at 6.5 mm. from the apex the breadth was 10 mm.; as he believed this width would insure the safe passage of a lens of 9 mm. in diameter, but it is questionable whether with so obtuse an angle the knife could be thrust into the anterior chamber at all. In support of this suspicion is his statement that in regard to the cutting qualities of his knife he had some complaints to make, but that later he was completely satisfied with the work of his instrument-makers. Claiborne's experience in that line leads him to doubt the efficiency of a heart-shaped knife which at 6.5 mm. from the point possesses a breadth of 10 mm. The angle is too obtuse for a stab wound to be made easily. The knife which Claiborne devised, however, enters the anterior chamber with as much ease as any of the lance-shaped keratomes he has ever used. The angle subtended by the point of the Weber knife is 73.5 degrees. After performing his first operations Claiborne became convinced that he could use a knife with a broader base with greater certainty of success.



Claiborne's Lance-Shaped Cataract Knife and the Linear Section made by it as compared with Weber's (a) and his own section (b).

It will be observed that Weber estimated the depth of the anterior chamber at 12 mm., but Claiborne believes it to be still deeper, 13 mm. In view of these findings, he had Tiemann make a "final" knife with a base of 14 mm., and a length up to the base line of 10 mm. It will be observed that there are about 2 mm. of blade above and beyond the base line, after the manner of the ordinary lance-shaped keratome; this gives the knife 2 mm. more length and insures the entrance of the point well into the lower iridic angle.

Claiborne believes that the time which elapses between the puncture and the completion of the Graefe section is fraught with danger at every second and is a trial alike to the nerves of the patient and the surgeon. During this time there is danger of too great pressure with the fixation forceps, of pricking the lid or nose by the point of the knife, of "squeezing" the lids and of general nervous misconduct on the part of the patient, with consequent destruction of the eye by loss of vitreous.

Claiborne employs his lance-knife as follows: "The surgeon should stand behind the patient and a fixation forceps should be applied directly below the cornea opposite the point of entrance of the knife. The eye being rotated downward, the point of the knife is entered about 1 to 2 mm. behind the sclero-corneal margin in the median plane of the vertical meridian. The knife should then be shoved straight across the anterior chamber until its apex arrives at the limit of the inferior iridic angle, when it should be withdrawn slowly; a cutting motion to the right being made at the same time to enlarge slightly the size of the wound, if the operator thinks necessary. If the knife is withdrawn too quickly, aqueous escapes rapidly and the iris is apt to prolapse. Either the simple or combined extraction may be performed." Claiborne prefers the combined methods, as it renders the exit of the lens easier. Care should be taken to maintain the point of the knife in the same plane in which it entered. The section is executed within three seconds, and forms a marked contrast to the time required to perform the Graefe section.

The advantages of a section made by this knife are stated as follows: 1. There is no counter-puncture. 2. The section is made in the plane of the support furnished by the fixation forceps. 3. The wound is a stab-wound, and by virtue of that fact is smooth; no sawing motion is employed. 4. The section is practically finished by shoving the knife home. 5. There is no loss of aqueous while the section is being made, because the knife increases in thickness from the apex to the base, and the farther it penetrates in the tighter it stops the wound. 6. The iris is not so apt to prolapse on withdrawing the knife, because the broad back of the knife holds it in place. 7. The iris cannot fall before the knife from loss of aqueous because no aqueous is lost during the section on account of the shape of the knife. 8. Perfect apposition of the lips of the wound by virtue of its smoothness; rapid healing; less liability to suppuration; less post-operative astigmatism. 9. Use of right hand for both eyes. 10. If the knife is entered properly and shoved home, the section is bound to be correct; it automatically commands success. 11. Less danger of prolapse of vitreous, because of the support furnished by the broad back of the knife. 12. Diminished time.

The simple versus the combined operation. It would require many pages to discuss the merits and defects of the two principal methods of extracting senile cataract. Probably the proper form of inquiry should relate not so much to a decision as to which is the better method, but to an attempt to decide the cases in which one operation ought to be performed in preference to the other. In other words, a selection of cases is called for because it is undoubtedly true that one operator may employ the simple method too much.

The chief complication and, it might be added, the chief objection to the operation without iridectomy is the more frequent occurrence in it of iris prolapse and the difficulties in dealing with cortical matter. Both these drawbacks are associated with their attendant evils, uveitis, astigmatism, irregular pupil, secondary cataract, etc., and it is a question whether the simple operation should be done in every instance by one who has not had considerable practice in dealing with the complications that are most likely to occur.

The writer's preference is for the simple procedure in most cases of hard, mature, cataract occurring in healthy, right eyes. On the left side, or in any case where there are deviations from what might be termed the normal type of senile cataract, it is wise to make some form of iridectomy.

The exsection of the iris does not materially differ in extraction of cataract from that done for some other purpose, except that it should be small and the margins of the coloboma carefully replaced before the toilet of the wound is completed. As is well known, the purpose of iridectomy is to lessen the probability of prolapse, glaucoma and post-operative infection. Inasmuch as the results obtained by operators will always vary to a large extent it is impossible to set forth all the advantages and disadvantages of an iridectomy in senile cataract extraction.

Czermak and Elschnig *(Die Augenärztlichen Operationen,* Vol. II, p. 453) give the following advantages and disadvantages of both operations.

The advantages of the simple operation are quickness and ease of procedure; the slighter trauma and the barrier to vitreous and ciliary injection on account of the uncut iris; the cosmetic advantage of a round pupil; the optical advantages of the round, central pupil, because of the better visual acuity, orientation, and the screen-like effect of an intact iris; better healing of the corneal wound and, finally, the rarer occurrence of vitreous loss during an operation.

The disadvantages of the simple operation are: The necessity for a larger corneal incision, which predisposes to infection and iris prolapse; further difficulties in extracting the lens and in expelling cortical and capsular remains; more frequent secondary cataract and the greater necessity for secondary operations; more frequent prolapse of the iris: the difficulty that some operators experience in performing this operation as compared with the combined extraction.

The advantages of the combined extraction are: Easier removal of the cataract and cortical remains; a smaller incision and, consequently, less exposure of the wound surfaces to infection; less liability to prolapse of the iris; fewer chances of glaucoma and inflammatory reaction; a greater certainty of the results.

Among the disadvantages of the combined operation are greater probability of complication owing to the longer time required for the operation; wounding of the iris together with the pain and bleeding that attends it; the danger of minor incarcerations of the iris, with capsular remains in the corners of the wound, and of their sequels (cystoid scar, small staphylomata, iritis, irido-cyclitis and sympathetic ophthalmia); slight incarceration of the capsule; inferior visual acuity, diminution of peripheral sight and, in consequence, defective orientation; greater liability to post-operative glaucoma on account of iridic and capsular hernia.

However, the dictum of Terrien (*Chirurgie de l'Oeil,* p. 149) that the simple operation is the procedure of choice and the combined one of necessity or selection (opération d'exception) is probably true. In any event, it is better to do an iridectomy in rigid irides, or those that are not quickly affected by mydriatics; in unripe cataracts; in diabetic cases, and whenever there is any suspicion of posterior synechiæ. To this category might also be added hard cataract occurring in high myopes or in patients having any of the undesirable complications elsewhere mentioned. The iridectomy thus made is one rather of prevention and prudence; the unmutilated iris and the round pupil should be retained if possible.

Preliminary iridectomy. It is a question as yet unsettled whether an iridectomy done a few days or a few weeks prior to the extraction of the lens is or is not, on the whole, in the interest of the average patient. Doubtless, it is desirable in certain cases. It was first practised by von Graefe, who found the double operation to be safer (though less convenient) than the whole extraction in a single sitting. Mooren seems to have been the first, however, to advise the operation in all cases of cataract that require iridectomy.

Reber (*N. Y. Medical Journal,* April 6, 1907.) has been impressed with the idea that the operation of preliminary iridectomy offers the patient the largest chance of success, and because of this conviction he has been pursuing this method whenever possible. It is because of the frequent opposition from both patients and their family doctors (not to mention a few of his closest ophthalmic friends) that he ventured on a collective investigation that might embody the views of the majority of prominent American operators concerning the method of extraction of cataract with preliminary iridectomy. With this end in view, a circular letter was sent to 160 American ophthalmic surgeons with an enclosed blank containing the four following questions:

1. Do you ever do preliminary iridectomy? 2. For what conditions? 3. Why? 4. If a cataract patient has lost one eye by operation (or whatever cause) would you do preliminary iridectomy if the patient's time would permit? and, if so, why?

For a long time it has been the contention of many American ophthalmologists (and particularly Philadelphians) that in sedentary persons of gouty, rheumatic or diabetic diathesis or, for that matter, perverted metabolism from whatsoever cause, errors of refraction that had been allowed to go uncorrected up to 50 to 60 years of age were likely to set up low chorioido-retinal disease, which sooner or later manifested itself in fine granular opacities in the vitreous humor along with cloudiness at the posterior pole of the lens, and beginning opacification in the lens periphery.

Commenting on the fact that in this day and generation, when there is general agreement as to the operability of most immature cataracts, the proportion of classic senile mature cataracts to the total number operated on is small, Reber considers the status of these partially matured cataracts as sick eyes belonging to patients whose diatheses are almost sure to influence the healing process.

He then discusses the question of iridectomy and whether it should or should not be performed. He reviews the arguments against iridectomy: 1, The cosmetic effect is poorer; 2, it is not only needless, but more dangerous because of more traumatism; 3, vision is poorer because of iridectomy; 4, it necessitates a longer operation; 5, there is more dazzling after iridectomy; 6, the vitreous is not so well retained; 7, it is not justifiable to subject the eye twice to the risk of infection.

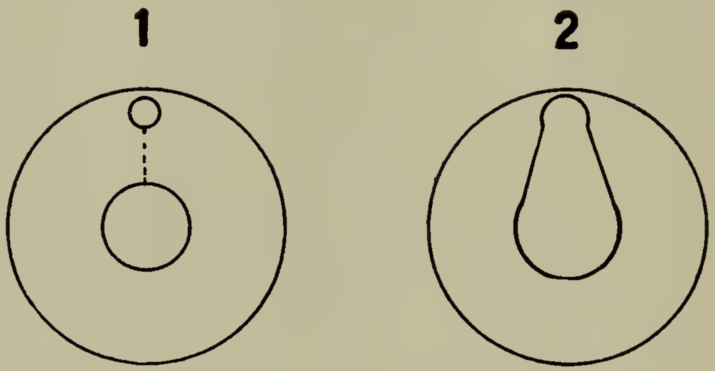
Next the argument for extraction with iridectomy is taken up: 1, It does not require as large an incision; 2, capsulotomy is more readily done; 3, delivery of the lens is easier; 4, fewer secondary operations become necessary; 5, iris prolapse is rare; 6, any glaucomic tendencies during the healing are probably forestalled; 7, less confinement to bed; 8, hemorrhage.

He considers the question of preliminary iridectomy and mentions six arguments against this procedure: 1, Increased risk in operating the eye twice; 2, increased astigmatism on account of the two incisions in the cornea; 3, the necessity for cutting through scar tissue, which heals poorly, when the extraction is done; 4, patients stand a first operation with more fortitude and less strain than a second one; 5, a needless mutilation, since it is claimed that the eventual chances of success are no greater by reason of preliminary iridectomy; 6, consideration of the patient's time. He answers all of these objections and gives Coleman's arguments in favor of preliminary iridectomy; 1, The maturing of an unripe cataract is frequently hastened; 2, the diagnosis of the character and size of the cataract are facilitated; 3, the surgeon learns of the amount of self-control possessed by the patient; 4, during the extraction there is no hemorrhage from the iris; 5, the iris does not fall in front of the knife; 6, there is an unobstructed doorway opened for the cystotomy and expulsion of the lens and cortex; 7, there is no pressure trauma of the iris as occurs in the simple operation; 8, the iris has healed, leaving only the corneal incision to heal; 9, the operation is shorter and less painful than the combined method; 10, it lessens the danger of iritis, also of glaucoma; 11, it is the operation best suited to complicated cataracts and not unsuited to any; 12, there is less need for subsequent needling operation. To these the writer adds: 13, the surgeon by doing the two operations will acquire skill in ocular operations in one-half the ordinary time; 14, any latent dyscrasia in the blood is altogether likely to reveal itself during the healing after the iridectomy, and the patient may thus be prepared by suitable treatment for the final operation.

Out of 83 available replies, 47 believe that for most cataracts preliminary iridectomy is a safer procedure than combined or simple extraction; 19 more believe that preliminary iridectomy is the safer thing to do in the presence of complications; and 17 feel that the chances of success for their patient would be in no wise enhanced, but somewhat jeopardized, by preliminary iridectomy.

Extraction with peripheral iridectomy. Bell Taylor in 1871 and C. Hess recently (*Archiv. f. Augenheilk.*, 1910, p. 33) have advocated the excision of a piece of iris beneath the corneal incision, thus preventing iridic prolapse during the wound healing and still preserving a round, central movable pupil. Following this plan Hess has done 600 extractions with only 0.66 per cent. of iris prolapse.

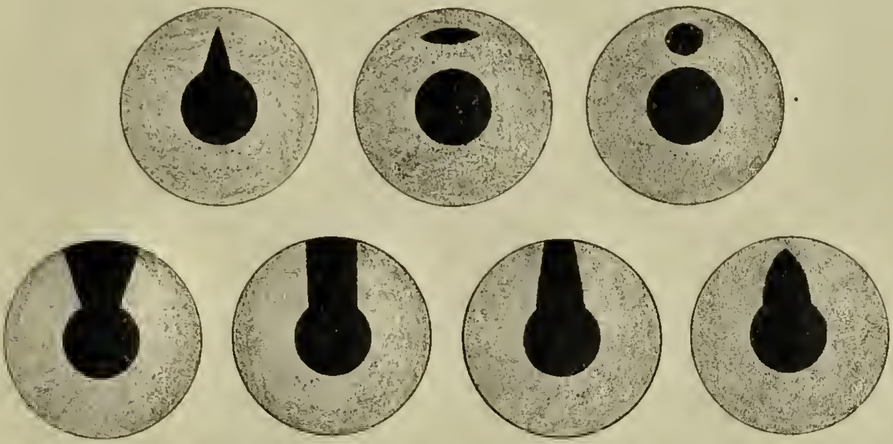
Extraction with iridotomy. Verhoeff makes the corneal incision in the usual manner. The iris is then grasped with the forceps as near its root as possible and a small bit of tissue excised with scissors so as to leave a small hole in it. (See the figure.) The iris will immediately return to the anterior chamber of its own accord. de Wecker's small iris scissors, preferably with blunt-pointed blades (Noyes' scissors will probably serve as well), are then introduced through the corneal incision, gently opened, and one blade passed downward through the hole in the iris until it projects below the pupillary margin. The blades are then quickly closed, thus making a clean cut through the iris to the pupil. Owing to the mydriasis produced by the cocain, the edges of the incision will separate, usually at once, as widely as after an ordinary iridectomy. If, however, the iris is pressed against the cornea by the lens, this may not happen until after the lens has been extracted. The lens capsule may now be opened with the cystotome or capsule forceps and the lens expressed in the usual way, or the latter may be extracted in its capsule. In making the toilette of the wound, care should be taken, as after an iridectomy, to free the pillars of the coloboma from the incision. It is probably best to instil atropine immediately after the operation, since this enlarges the coloboma and thus lessens the danger of iris prolapse.



Verhoeff's Modified Iridotomy as Compared with the Usual Iridectomy.

This operation offers the advantages of both the simple and combined operations without their disadvantages. The lens is removed with the same ease as in the combined operation, the danger of iris prolapse is minimized, and cortical matter can be expressed with even greater facility than after an iridectomy. Moreover, the modified iridotomy requires no such rough handling of the iris and causes no such pain as iridectomy, while it is superior to the latter in its cosmetic and optical results. The excision of iris tissue is made where it will be most effective in preventing iris prolapse and at the same time do the least damage from an optical standpoint. In the case of iridectomy, a large section of the sphincter muscle is always removed so that the reaction of the pupil to light is necessarily much impaired, whereas in this operation the sphincter muscle is simply incised and the pupillary reactions less interfered with. For this reason, as well as on account of the narrow coloboma finally obtained, the dazzling on exposure to bright light often complained of after iridectomy is, after this method, notably absent. The optical results are, in fact, practically as good as after the simple extraction or the Chandler button-hole operation.

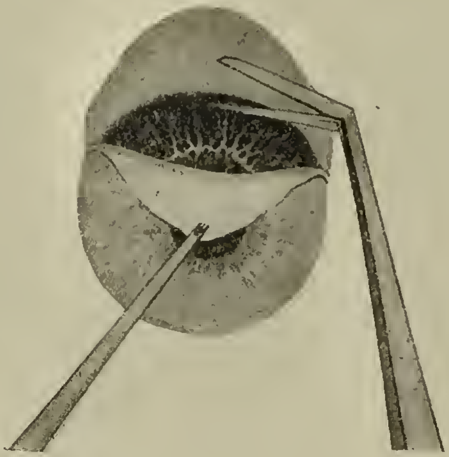
Chandler, to prevent prolapse of the iris, makes a small peripheral button-hole opening in that membrane after the delivery of the cataract. At first he simply perforated the iris with his knife, but he now removes a piece of tissue 1 mm. in diameter, making the round opening as near the root of the iris as possible. The object of this small, circular opening is that it not only allows drainage of the intraocular fluids but the cortical matter that collects above and under the iris can be pressed through the opening. Moreover, in washing out the anterior chamber the fluid flows backwards through the opening and carries with it all cortical débris. In performing the operation he tries to make his cut exactly at the scleral-corneal junction. After the lens has been delivered, he allows the iris to prolapse for a few moments, knowing that he can remove cortical matter through the opening in it. As a result of this method he has had only three cases of vitreous loss in 312 extractions. Among these there were also four cases of prolapsed iris but two of them were the result of direct violence. In two others it occurred on the second day; the opening having been made too far forwards. Chandler uses forceps with the teeth at the tip, and scissors whose blades are very thin; otherwise the opening is made too large and farther down than it should be. The opening is made after the expression of the lens, as it seems that the small amount of aqueous under the iris acts as a buffer and facilitates its extraction.



Extraction of Senile Cataract.

Some of the iridectomies and iridotomies made in various "combined" methods.

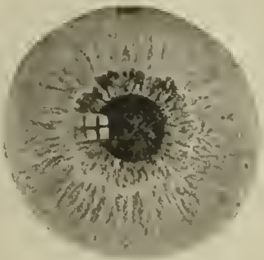
Peripheral iritomy as a safeguard against prolapse of the iris. Bajardi (as Chandler formerly did) perforates with the point of the cataract knife the periphery of the iris immediately after the corneal puncture, which he makes at the limbus. The point of the knife transfixes the iris and cuts its way through about one-fifth of the circumference of the iridic circle. The knife point is then withdrawn sufficiently to clear the iris, the counter-puncture is made in the usual way and the section is completed. The capsule is then incised with the cystotome (if it has not already been done by the knife) and the lens is delivered, if possible, through the button-hole opening in the iris. The iridic wound sometimes does and sometimes does not entirely heal, but in any event it affords an opening through which the aqeuous, as well as lenticular débris, may escape. Bajardi pictures many cases operated upon by him and feels much satisfied with the result of the operation.



Senile Cataract Extraction. The Peripheral Iritomy of Elschnig.

Elschnig (see H. Gradle, *Annals of Oph.*, July, 1912, p. 449) is an enthusiastic advocate of peripheral iritomy in cataract extraction. His procedure is as follows: After the regular incision and capsulotomy have been performed, the corneal flap is grasped with a forceps and laid back. The iris, completely exposed, is then incised close to the scleral lip of the wound (with the small pointed branch of a de Wecker or Esbach scissors), practically raising a fold of the iris and making an incision about 1 mm. long parallel to the edge of the cornea. In order not to mutilate the surface of the iris too badly, the incision must be kept well near the scleral lip of the wound, for the incision through the limbus (comprising one-third to two-fifths of the circumference of the cornea) is well subconjunctival. The operators who prefer a primary peripheral incision will undoubtedly find the iris incision easier nearer the root of the iris.

Of course, the iris incision can be made immediately upon opening the eye, but it is better to carry out the more important capsulotomy first before the patient has become tired. In those cases that show the maximal mydriatic effect of the cocain, even after the capsulotomy, the iris incision should be made after delivery of the lens and reposition of the iris, for the danger of incising the body or the sphincter of the iris is too great. Injury of the vitreous is, of course, possible, but improbable when proper care is exercised.



Senile Cataract Extraction.
Peripheral Iritomy of Elschnig, After Healing of the Wound.

If the operator has had no experience with this technic, it is much safer to perform the iris incision with the lens present. If the incision be too large, the upper edge of the lens may present itself therein instead of in the pupillary area, as occurs so frequently with a peripheral iridectomy. However, this can be easily replaced by light pressure with the spatula. As emphasized before, this incision must lie in the root of the iris and must not be longer than 1 mm. After smooth reposition of the iris and the conjunctival flap, a few drops of eserin are instilled and an adhesive plaster bandage applied over both eyes. On the same afternoon the bandage is loosened, and on the next morning atropin is instilled and the second eye left open.

In many cases the iris incision is but scarcely visible after the wound has healed. In six of the 287 cases some iris tissue on one or both sides of the iris incision was adherent to the posterior surface of the corneal wound, thus causing the pupil to be slightly eccentric, but never was the iris included in the wound.

''How this iris root incision prevents prolapse is so simple that it does not need any explanation. Unquestionably it is the pressure of the aqueous which collects behind the iris and balloons it forward, forcing open the corneal wound and jamming the iris into it. This occurs especially when the patient 'squeezes,' i. e., causes pressure with the lower lid against the lower portion of the cornea. I believe that a contributing factor toward this is the adhesion between the iris and the remnants of the anterior capsule, or, in case of a Smith extraction, the vitreous. Thus there results a ring-shaped synechia such as we find in cases of iritis (iris bombé), bulging forward of the iris, opening of the corneal wound, and incarceration of the iris in the wound. The 'squeezing' of the patient contributes greatly to this.

"As a result of experience I believe that the iris root incision is a positive preventive measure against iris prolapse in simple extraction. Still I am not of the opinion that every case can be extracted without an iridectomy. During the time that I performed the 287 simple extractions, I also performed 61 extractions with iridectomy, among them 26 extractions intracapsular, according to the Smith technic.

"The simple extraction is absolutely contraindicated if a previous instillation of homatropin does not produce a mydriasis of at least 5 mm. The recognition of the rigidity of the iris, which cannot be decided by any morphologic characteristics, will determine whether a lens with a large nucleus can be delivered through a round pupil without tearing the sphincter or otherwise destroying the integrity of the iris.

"In contradistinction to these absolute contraindications to simple extraction, the two previously mentioned must be regarded as relative. To the danger of iris prolapse due to very prominent eyes, abnormally wide palpebral fissures, or unusual tenseness of the lids, one must always add the fact that the patient may be of such a character that a reasonable behavior after the operation cannot be expected. Every 'squeezing' by the patient during the first twenty-four hours may cause a gaping of the wound and a prolapse.

"To the relative contraindications must also be added adiposity, heart lesions (high blood pressure), and bronchitis, especially when complicated with emphysema. Disturbances of metabolism belong to this group, for they may cause the frequent iritis post extractionem. But I have successfully performed many simple extractions in patients in whom one or more of the above mentioned relative contraindications existed."

Dean W. Myers, of Ann Arbor, Mich. (Central Vision in Aphakic Eyes and a New Method for preventing Prolapse of the Iris. *Homeopathic Eye, Ear and Throat Jour.*, Feb. 1910.), has also made use of this procedure, first described by Schweigger (see his account of the downward corneal section). He says:—"There are many cases in which a marked tendency to prolapse of the iris occurs at once following removal of the lens and many authors recommend in all such cases an immediate iridectomy. To overcome this tendency and avoid iridectomy, I have conceived the idea of an iridodialysis at a point in the attachment of the iris corresponding to the center of the primary incision. This I produce by simply passing the ordinary cataract knife directly through the attachment of the iris, thus making a small opening through which the fluids of the eye may escape directly into the corneo-scleral incision without carrying the iris with them. This permits the iris to float in the anterior chamber until the incision is closed.

"So far it has served us admirably in our work; not a case upon which it has been performed having had the slightest prolapse. In the majority of cases this small opening will close in a few days; but in those cases in which a permanent iridodialysis remains the defect is covered by the corneal scar and overhanging upper lid, giving the patients no trouble from a visual standpoint and being hidden from the observer's eyes by the same means."

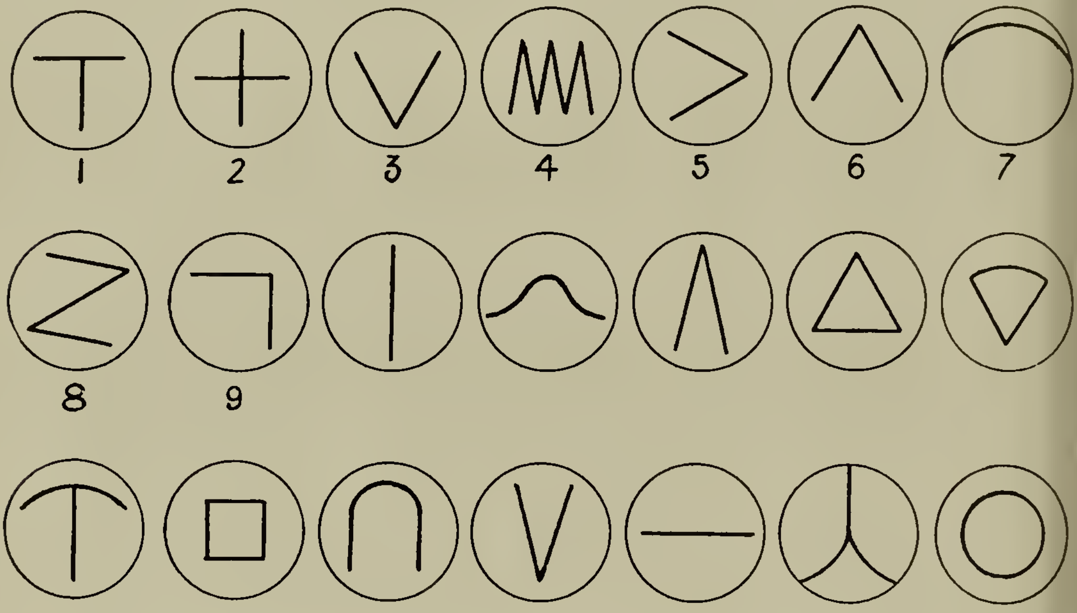
Incisions into and removal of the anterior capsule. Cystotomy. The methods of opening the capsule are extremely numerous. From the earliest times surgeons have endeavored to incise the anterior capsule in such a manner as not to leave tags of capsule or flaps that would be likely to engage in the wound or to remain in the pupillary area and so interefere with vision. To prevent a secondary cataract of this character is the principal object of the great variety of cuts in the anterior capsule, and other procedures upon that membrane preceding the extraction of the lens. The fact is, of course, that no ingenuity in making an anterior capsular incision will prevent thickening of the posterior capsule. It is, unfortunately, often alterations in and deposits on the posterior capsule that make it necessary to do secondary operations.

There is another important purpose in a properly made capsular incision, apart from permitting an easy escape of the lens, and that is the prevention of iridocyclitis and secondary glaucoma from the retention of capsular tags. These remnants sometimes include lenticular matter and both acting together block the iridic angle. Treacher Collins has discussed this matter fully and gives it as his opinion that many cases of failure of cataract extraction are due to this cause. The incarceration of a portion of the capsule in the extraction wound is always a dangerous condition. Not only does it delay healing (because the small tag acts as a foreign body), but the hernia of the capsule allows the entrance of septic organism and acts as a drag upon the ciliary body.

One of the advantages of simple extraction is that it is more difficult for the capsular incarceration to occur if there has been no iridectomy. Moreover, should such an accident happen at the time of the operation it is much easier to reduce the piece of capsule than after a combined extraction.

These considerations make it highly desirable that, as Swanzy recommends, the point of the iris forceps should be passed, as a routine measure, between the lips of the sclero-corneal wound and all hernial matter drawn out before the cataract dressing is applied.

Although there are numerous forms of capsulotomy, yet they may be divided into four classes; first, that made by some form of cystotome through the corneal opening; second, that made by the cataract knife during the incision for extraction; third, the preliminary cystotomy; and, fourth, removal of a piece of the capsule by means of specially contrived forceps. These methods will now be considered in their order.



Forms of Capsulotomy. The Circle Represents the Dilated Pupil. (After Beard.) Those incisions that make angles whose bases are toward the corneal incision are bad because their flaps and tags get into the wound, cause iris prolapse and delay healing. 1, Von Graefe; 2, Von Graefe (crucial); 3, Von Arlt; 4, Von Arlt; 5, Weber; 6, de Wecker; 7, Knapp; 8, Czermak; 9, Agnew.

Cystotomy is by far the commonest method and presents the most numerous variations. As already stated, too much attention has probably been given to the necessity of some particular form of this procedure. As a rule, the anterior capsule, when incised, rolls upon itself so that its margins are carried away from the pupillary space. If this be true it matters little what variety of incision be made, provided it is a clean-cut one, and large enough. Some surgeons, however, insist upon making the most elaborate, and, it seems, needlessly complex, figures upon the anterior surface of the lens.

Although it has been highly recommended by experienced operators to make a single incision following, more or less, the outline of the upper part of the lens, so as to admit of easy extraction of the cataract, yet the anterior capsule is more likely, in this case, to come in contact with the posterior, to include some lens matter between the two layers, and thus favor the formation of a dense secondary cataract. In spite of this objection there are experienced advocates of it. Knapp, for example, prefers peripheric splitting (as he terms it), as opposed to vertical splitting. He thinks that the latter is unfavorable for the exit of the lens, while the former, parallel with corneal section, offers it the easiest way of escape. He then refers to the capsulotomy of Graefe, who opened the capsule horizontally in its upper part with a cystotome which he then turned and tore the capsule from below upwards to meet the horizontal incision. In this way he made a broad T-shaped opening, which, however, was not always large enough and was abandoned owing to the objection of placing difficulties in the way of the removal of the lens.

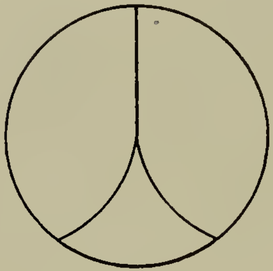
A long incision following the vertical meridian is perhaps better than the peripheral cut since, after it, the margins of the wound usually fold up and roll away from the pupillary area.

Making such incisions as to cut out a circle, a triangle or a parallelogram from the anterior capsule is attended by some difficulties. First of all, unless the cystotome point be very sharp and the incision made very exact, the operator fails to remove the piece entire and the result is a separate piece of capsule held in place by a tag that may engage in the wound of operation. As previously mentioned, however, a triangle with the apex pointed downwards and the base curved to correspond with the lens margin, gives, on the whole, the best results.

The upper peripheral capsulotomy was first introduced by Gayet, who made it principally as a part of the combined method. He incised the capsule at the equator of the lens, after tilting the latter forward by pressure below the middle of the cornea. Quioc divided the capsule at its periphery along the whole length of the corneal wound.

Notwithstanding the stated objections to it, the method of Knapp, owing to the large experience and value of the opinion of that writer on this subject, is detailed here.

The operator introduces the cystotome into the anterior chamber with the knee forward, from the temporal side, near the conjunctival flap, which latter he is careful not to drag into the eye. He then advances the instrument so that the tip goes beneath the upper part of the iris, turns it and with the tooth makes the incision into the upper part of the capsule parallel with the corneal section, about 6 to 7 mm. in extent. As soon as the capsule is opened the lens makes a visible motion. The cystotome is then withdrawn with the knee forward so that the point does not engage the iris. Knapp claims several advantages for this form of capsulotomy in that there are no shreds to unite with the lacerated pupillary margin and consequently there are no posterior synechiæ. The lens also escapes easily and there are no tags of capsule to engage in the wound, although if an iridectomy has been made there may be adhesions between the capsular and corneal incisions. Although cortical remains become enclosed by free union of the two capsules, irritation of the iris is avoided and the soft matter, to some extent, becomes absorbed. As mentioned before, the drawback to this method is the frequent necessity for an after-operation.



Barcks' Fan-Shaped Capsulotomy.

Barck has abandoned Knapp's peripheric method and gradually developed the following: The first incision is of a crescentic shape, commencing laterally from the lower end of the vertical meridian; the second, commencing just as far mesially from this, meets the first somewhat above the center of the capsule. (See the figure). It is very important that the two incisions really intersect. If correctly carried out, the lower triangular flap as a rule falls downward, and the upper portion retracting, leaves a clear, central pupillary area.

Preliminary capsulotomy. A few operators prefer to open the capsule, by means of a needle or knife-needle, either immediately or several days or weeks before completing the operation of extraction. Herbert says that this is the routine practice adopted by a number of East Indian surgeons. Haab has employed this method in the cataract of childhood and believes that useful information can then be obtained as to the condition of the cataract itself. He believes that it is also possible to make a better and more definite capsular opening, since the operator can take his time and the field of operation is not clouded by the presence of blood or any other discharge. Moreover, the pupil can be more widely dilated than after the anterior chamber has been emptied. The needle is inserted at the limbus and with a little care there is no escape of aqueous.

The writer has done a preliminary capsulotomy in a number of cases where there was reason to suspect a thickened and adherent anterior capsule, and has never had occasion to regret the procedure. I believe that this is the only reliable "ripening" operation and if the case be closely watched do not see what disadvantage can arise after it, especially if the case be selected.

L. Müller does his capsulotomy (in the combined operation) before the iridectomy so that the upper part of the capsule may float or curl up behind the iris, thus keeping away from the corneal wound.

Bribosia's operation involves an immediate and preliminary laceration of the capsule by a stop-needle. The knife is then passed across the anterior chamber, the iris is caused to prolapse upon the knife as the incision is made and the iridectomy is simultaneously performed. The remainder of the operation does not differ from the usual extraction methods.

Preliminary rupture of the capsule before making the corneal section. Drake-Brockman says that a few surgeons of repute in India, especially in Madras, urge the importance of this procedure more or less as a routine practice. He cannot personally see much advantage to be gained by such procedure as a matter of routine, but in the case of Morgagnian cataracts he thinks it is a sound practice to do so on the ground that it is less likely to be followed by escape of vitreous which the sudden release of pressure on the hyaloid membrane will usually entail if laceration of the capsule is left till after completion of the corneal section. It must be borne in mind that the vitreous itself, in cases of Morgagnian cataract, is usually more liquid than normal, rendering vitreous escape more inevitable. The slight inconvenience, if any, of the presence of milky matter in the anterior chamber he has never found seriously to interfere with the making of the corneal section in an efficient manner. These cases, however, should, in his opinion, be invariably followed by thorough irrigation of the anterior chamber and accurate reposition of the iris.

Homer E. Smith practises this method which he describes as follows: A speculum is introduced and the fixation forceps applied. With a small Knapp's knife-needle a puncture is made through the upper part of the cornea, the blade carried down to the lower margin of the dilated pupil and then brought to its upper border, making an incision not only through the capsule, but partly into the lens substance itself. A similar cut, but at right angles to this, is then made in the mid-pupillary space and the knife is withdrawn. The speculum and fixation forceps are then removed, the eye flushed with an antiseptic solution and a bandage reapplied.

Smith believes that the capsulotomy furnishes valuable information that may guide the operator in the size of the corneal section he will later make. If the cut in the capsule is practically invisible, then it is known that a large nucleus is present and the usual section of the upper two-fifths of the cornea will be required for the easy exit of the lens. If there occurs an escape of semi-gelatinous lens matter, then a section of one-third will suffice, while if there issues a milky liquid then it is known that the cataract is hyper-mature and the section may be made with the angular keratome. Therefore, no larger a section is made than necessary and a minimum of risk during the healing process assured. Twenty-four hours at least should elapse between the capsulotomy and the extraction because there is usually a sufficient loss of aqueous to render the eye soft and a proper corneal section difficult.

Opening the capsule with the cataract knife during the corneal incision. This is the keratokystitomie of Gayet, who practised it many years ago. The point of the knife is made to incise the anterior capsule shortly after the puncture at the pupillary edge, carrying it across the anterior surface of the lens and as far as possible before the counter-puncture is made. It is best to make the puncture and counter-puncture in the anterior capsule as low down as possible and for this purpose the knife is directed rather downwards during this part of its course. This causes the incision to be semicircular in shape. Some operators prefer to extend the puncture vertically, but in attempting to perform this part of the operation aqueous is likely to escape and the corneal wound to be irregular. While this maneuver reduces the number of instruments passed into the anterior chamber during the operation, yet its disadvantages are many. In the first place the capsular incision is apt to be too small, especially in large, ripe lenses and if the capsule be tough or thickened. Added to these drawbacks is the possibility of pressing the lens backward in the attempt to cut a thick capsule, and of dislocating it afterwards if the transfixation be very deep. I have, however, seen good results in the hands of at least two surgeons, who have extensively used this method of capsulotomy, namely, Sir Anderson Critchett and Trousseau.

Puncture of the posterior capsule. This procedure is obviously indicated at the time of the extraction if there be a central opacity in the posterior capsule, because it renders unnecessary a second operation. However, some surgeons advise it as a routine performance so as to avoid the subsequent opening of the capsule. Both Schweigger and Hasner have advocated this operation, the latter not only to anticipate formation of after-cataract but to raise the cornea through the forward pressure of the vitreous in the adjustment of the wound margins, where the sclera is rigid and the cornea has collapsed. Hasner used a cataract needle and made an extensive vertical incision in the posterior capsule. During this operation the blepharostat should be removed and no pressure exercised upon the eyeball by the dressings until the corneal incision is firmly healed. That there be no loss of vitreous the act should be performed just before the post-operative dressing is to be applied—after cleansing the wound of incision and the field of operation.

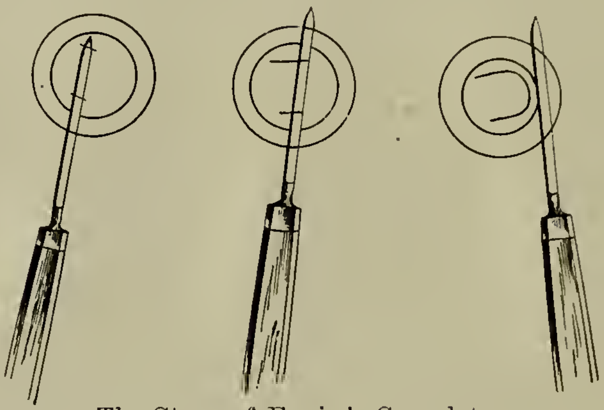
Webster Fox has been in the habit of opening the posterior capsule by means of a gilt enameled hook. It is of malleable steel that may be bent to any angle. This hook is passed into the anterior chamber and behind the lower pupillary margin of the iris. It is then rotated backwards, hooked into the capsule, drawn to the mouth of the incision, once more rotated and then removed from the chamber. By this means the capsule is torn and the vitreous pressed forward between the rent. It rarely shows at the mouth of the wound, but if it does is snipped off. Fox has been in the habit of performing this operation in alternating cases for ten years. As a result he finds that those patients upon whom the operation was performed required a secondary needling in only 15 per cent. of the cases; when it was not performed, in about 75 per cent. In the former class he attributes the necessity for the secondary operation to the vitreous receding from the wound after closing the eyeball and thereby not keeping the capsular lips separated, so that they closed again. He adds that there is less danger of inflammation of the eyeball after immediate capsulotomy than in a subsequent operation.

Other forms of anterior capsulotomy. Mark Stevenson uses a cystotome with a blunt end so that the iris is not injured when the instrument is pushed under it. It also has a sharp knife-edge that will cut either way. This instrument is passed, with its cutting edge backward, across the anterior chamber and for some distance under the distal portion of the iris, usually towards the nasal side. One straight cut is then made across the whole lens, across the pupillary area about 1 mm. from the edge of the iris into the coloboma made by the iridectomy, so that the incision extends as nearly as possible throughout the whole anterior capsule and not merely in its pupillary portion. The cystotome is then again passed under the distal portion of the iris but on the opposite side and a second cut is made passing more nearly to the center of the pupillary space and meeting the first incision at the beginning of the coloboma.

This operator believes that the method is a simple and easy one and that as a result of it there are no strips or tags of capsule that can possibly get into the corneal wound.

A. J. Erwin prefers the following course:

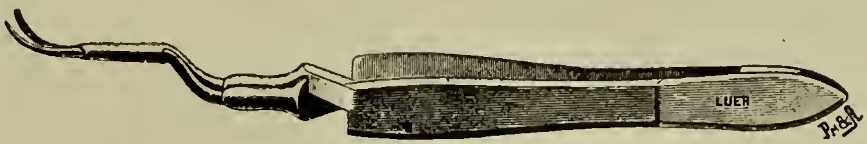
''Having dilated the pupil, I enter the cataract knife in the clear corneal margin at the equator. Advancing on a plane declining ten degrees from the horizontal, I transfix the capsule, then raise the point of the knife and counter-puncture the cornea two or three mm. above the equator, and complete the corneal flap in its clear margin. Unless the capsule be unusually brittle the knife will pass up under it to the pupillary margin, cutting a smooth central flap about the size of the ordinary pupil, which will be enlarged by the passage of the lens. This large flap will naturally fall to the lower segment of the capsule, leaving a clear pupil. This operation seems to me to be so safe, so complete, and withal so easily made, that I cannot comprehend why it has not been commonly adopted. Of course, there are cases that require the forceps or cystotome, especially the contracted pupil, requiring an iridectomy, but even in this class a central vertical slit can be made in the same way, which will often be sufficient for the escape of the lens after the completion of the iridectomy. I believe my results have been unusually good.''



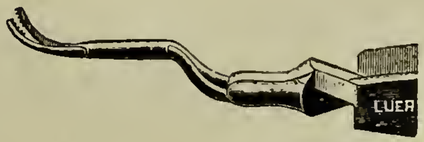
The Steps of Erwin's Capsulotomy.

Capsulotomy in opaque, thick and tough capsules. The difficulties in dealing with these abnormal membranes have been referred to several times. It may be added here that especially in Morgagnian cataracts (so often provided with opaque capsules) the capsulotomy must be made with an exceedingly sharp, needle-pointed cystotome. The needle-point should be quickly and firmly entered and some pressure exerted upon the sac while making the incision. Even then one may fail in doing a proper capsulotomy. For this reason, perhaps, it is well to resort to the method of Terson who employs a special capsule forceps, in addition to the cystotome, for dealing with these unusual cases.

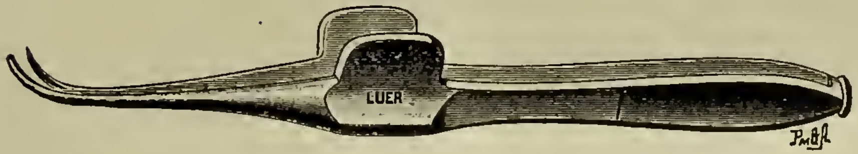
Herbert advises that one should make the primary cut in a Morgagnian capsule horizontal, and that this opening often has to be enlarged, even at some slight risk of the escape of the imprisoned nucleus.



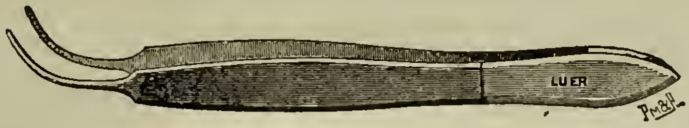
Abadie's Capsule Forceps.



Angelucci's Capsule Forceps.



Sauvineau's Capsule Forceps.



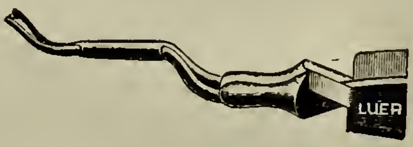
Graefe's Capsule Forceps.

In this connection one should remember that Knapp advised his "peripherie splitting" (q. v.) as especially adapted to the opening of these inelastic capsules.

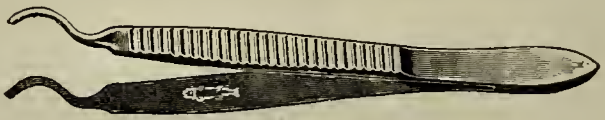
When the fluid has been absorbed in a Morgagnian cataract so that it consists mostly of the nucleus in a tremulous, shrunken bag, a capsulotomy is an extremely difficult and unsatisfactory operation. Should a capsulotomy (always with a very sharp cystotome) fail it is better to remove, very cautiously, the partially absorbed cataract in its capsule by means of hook or forceps.

When the cataract is not only over-ripe but plainly shows a circumscribed, central opacity (sometimes of the discoid variety) the method of Terson should be employed; or at least the capsule is best removed by the employment of both forceps and cystotome. Probably this form of cataract had best be removed in its entire capsule, as in the foregoing instance.

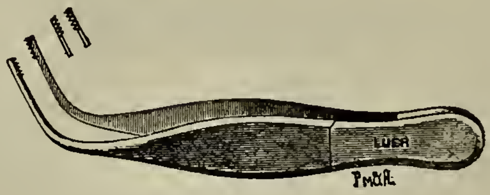
Removal of a portion of the anterior capsule. This is also a very old procedure, having been in vogue since the days of Daviel, especially when the capsule was found to be opaque. It was not until 1874 that Förster began to employ this method as a part of the routine extraction. It is now adopted by many experienced surgeons and is a procedure that has many advantages to recommend it. Although practised both in the simple and combined operations it seems better adapted to the latter method because the iridic coloboma offers a larger opportunity for the use of the capsular forceps. There are many forms of forceps and methods employed for this purpose. Probably the best known instruments are those of Couper, Förster, de Wecker, Eugene Smith, Terson, Sattler, Tooke and Lagrange, although many other operators (see **Instruments, Ophthalmic**) have from time to time invented instruments and presented them to the profession.



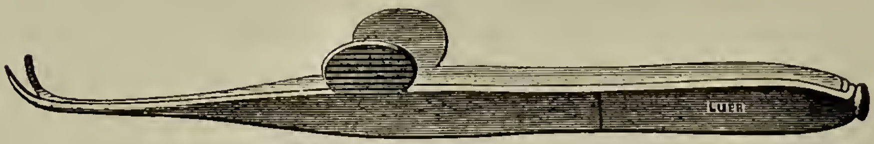
Terson-Luer Capsule Forceps.



Fischer's Capsule Forceps, Constructed so as to Avoid Injury to the Iris.



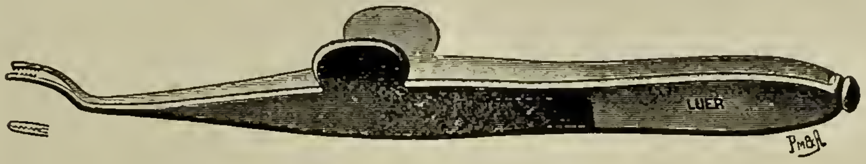
Fuchs' Capsule Forceps.



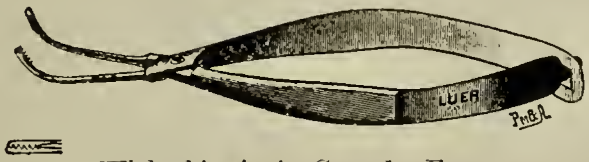
Panas' Capsule Forceps.

It must be remembered in this operation that even after the teeth of the capsule forceps grasp the anterior capsule near its center, the drag upon the membrane generally produces a rupture at or near the equator of the lens, because here the capsule is thinnest.

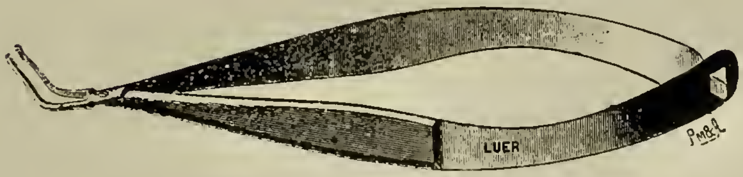
Capsule forceps. In performing the operation the patient is asked to look down and the eyeball is fixed below in the vertical meridian. The surgeon should have a clear view of the anterior capsule. The forceps are then introduced (closed) and the blades directed straight downwards. They are passed to the lower border of the pupil, and slowly opened to their fullest extent. The terminals are then pressed very carefully and slightly backward against the anterior surface of the lens and closed. The forceps are then—always gently—pushed downwards. By this latter maneuver the capsule generally ruptures above. With a careful side-to-side movement the instrument, with the torn piece of capsule, is removed from the anterior chamber. If this maneuver has been properly performed the lens will come forward and the subsequent extraction is easy. Failure to seize the capsule in the first instance may be followed by a second trial. In soft, semi-fluid or swollen cataracts, especially if the capsule be tough, it is not easy to grasp the membrane. In attempting to tear out a piece of capsule in this way care should be exercised not to use force of any kind or in any direction lest the suspensory ligament be torn, the lens dislocated or some other injury be done to the ciliary body.



Fage's Capsule Forceps.



Wicherkiewicz's Capsule Forceps.



Smith's Anterior Capsule Forceps.

If a reasonable attempt to use the capsule forceps fails a cystotome should be substituted, as repeated attempts to perform any step of a cataract operation is likely to demoralize the patient, while the efforts themselves may cause loss of vitreous or produce some other undesirable trauma.

Even when using his forceps, Terson, Sr., made a small opening with the cystotome in the lower part of the capsule when that membrane was found to be decidedly opaque. He believes that in each and every case the anterior capsule should be studied by the oblique illumination through the well-dilated pupils. If there are no markings on the membrane it is to be regarded as suitable for capsulectomy. If, however, there are visible markings the operator is advised to make a preliminary incision, as described, as this facilitates the removal of the capsule with the forceps. He directs, following his method, that the closed forceps be passed, as usual, to the lowest part of the pupillary area and there slowly opened to its widest extent. The teeth will then press into the capsule and the forceps close firmly on the anterior capsule. When the latter is seized the forceps are drawn slowly upwards with the customary side-to-side movement. He urges that the operation is one of some delicacy and that the seizing of the capsule should be carefully done, that no roughness should be allowed else the lens matter be dislocated and vitreous lost.

Finally, Birnbacher first outlines a piece of capsule with a special knife before applying the capsule forceps. This rather complicated operation is performed with the purpose of avoiding the danger of leaving loose shreds behind.

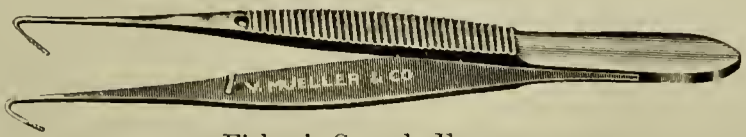
In small and rigid pupils it is generally desirable to do a wide iridectomy, in which case capsular forceps may be used but they are always contraindicated in rigid irides if the extraction be a simple one.

In any event, as much of the anterior capsule, which is generally about 9 mm. in diameter, as possible should be extracted. Both de Wecker and Förster believe that the excised portion should measure 6 or 7 mm.

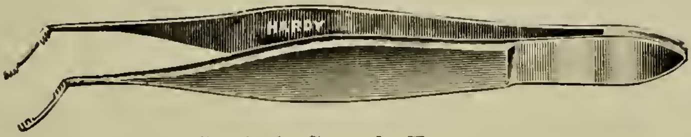
The most recent arguments in favor of the use of capsular forceps are those presented by Treacher Collins, who reports that in a series of 100 cataract extractions with this instrument only 4 per cent required needling and 25 per cent. obtained normal vision without secondary capsulotomy.

Mihail (Graefe's *Archiv. fuer Ophthal.*, Vol. LXXX. Part 2), mentions the Manolescu operation of *anterior capsulectomy* as being the nearest approach to removal of the lens in capsule. A broad fold of the anterior capsule is seized with a toothless forceps, and in most cases it is then possible to extract the whole anterior capsule, the equatorial capsule, and even a portion of the posterior capsule. Secondary cataract is prevented by the removal of the productive equatorial zone of the posterior capsular epithelium. In 2,647 combined and simple extractions there were only 114 operations for secondary cataract necessary.

W. A. Fisher has devised a pair of capsule forceps whose terminals are bent at an angle of about 40 degrees, so that the right-handed operator on the left eye may stand in front of his patient and not be obliged to change his position after the section has been made.



Fisher's Capsule Forceps.



Tooke's Capsule Forceps.

F. Tooke has devised a pair of capsule forceps whose handle is approximately 8 cm. long, tapering to a slender tip, where an extension arm of about 8 mm. is welded at an angle of 120 degrees to each blade. These tips are curved concavely below and conform to the underlying convex surface of the lens. The tiny, sharp teeth are directed downwards and inwards and interlock at the distal ends of the tips. This instrument has one or two advantages over other patterns. After inserting the tips into the chamber, pressure may be more evenly distributed over the whole zonular ligament, and consequently minimized at any one particular point where it must of necessity be exerted in other patterns where one point only is directed, as well as in the case where the cystotome is employed. The blades or tips of the forceps being curved concavely downwards an entanglement of the iris fibers need not occur.

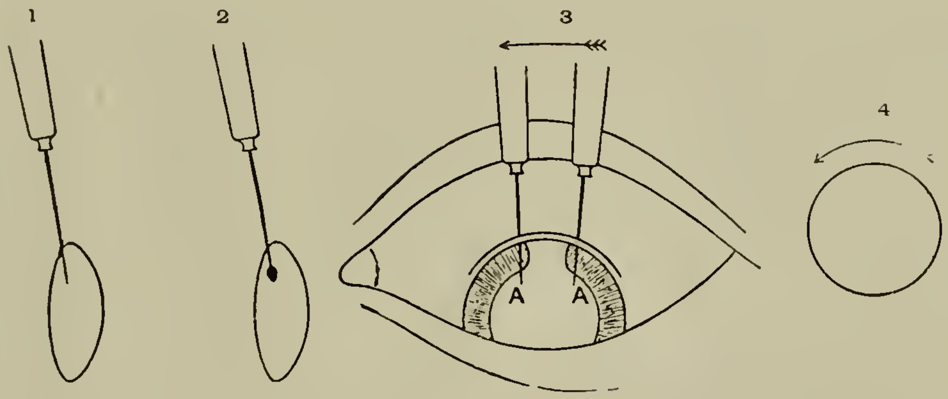
By means of a "swivel" cystotome J. G. Huizinga (*Ophthalmic Record*, July, 1911) believes that all the good results of capsule forceps can be obtained. The incision is made in the clear cornea or at the sclero-corneal margin, with or without iridectomy, according to the requirements of the particular case, or, in the judgment or choice of the surgeon, is made as usual. A "swivel" cystotome is introduced into the eye with the cutting-edge flat or sideways so as not to injure the iris or the capsule. It is pushed straight across the pupil and through it down and under the iris, opposite the corneal incision, to a point as near the margin of the crystalline lens as possible, without coming near enough to the suspensory ligament to injure it. The handle is then rotated on its long axis so as to bring the point of the cystotome into contact with the anterior capsule, and pierces it. The knife is then made to describe a circle of the largest possible diameter without going beyond the margin of the lens. In making this circular incision the point of the knife will be hidden behind the iris to varying degrees of depth at different steps of the procedure. When approaching that section of the circle corresponding to the corneal incision, it is necessary, if an iridectomy has not been performed, to draw the iris out of the way of the advancing cystotome with a blunt iris hook, so that the iris may not be injured, and to prevent the iris from forcing the point of the knife out of its prescribed course.

The advantages claimed by the author are as follows: 1. Practically the complete removal of the anterior capsule. 2. The retention of the posterior capsule to support the vitreous humor. 3. No loss of the vitreous. 4. Prevention of pocket formation, where lens débris may gather and be retained. 5. More perfect cleaning out of the anterior chamber after delivery of the lens. 6. The reduction of danger from inflammatory reactions, due to retained lens débris and adhesions between the anterior and posterior capsules, to the lowest possible limit. 7. Nearly all the advantages of the Smith-Indian operation without its dangers and difficulties.

Preliminary rupture of the zonula of Zinn. This procedure is generally done preparatory to extraction of the entire lens with intact capsules and several means of accomplishing this end are described under **Cataract, Intracapsular extraction of.** To these may be added an operation described by Geo. H. Powers (Wood's *System of Ophthalmic Operations,* Vol. II, p. 1214). He reports it as follows: "My discovery began with the accident of trying to incise a lens capsule with a cystotome which proved to be dull, and which, instead of cutting, rotated the lens on its horizonal diameter, thus plainly rupturing the suspensory ligament. As I almost always operate without iridectomy, I have hesitated to pursue the matter, but have proceeded to incise the capsule in the usual way before extraction; but I have a good many times done this rotation of the lens and have never failed to accomplish it without any force or appearance of possible damage to the eye. In the last case on which I operated I had made an iridectomy four years ago, and concluded to try to extract the lens in its capsule. With the eye well cocainized after an incision, including nearly one-half the periphery of the cornea, I passed the cystotome to as low a point as the iris would allow, plunged it into the lens substance (a little more deeply only than if intended to incise the capsule alone), and then with the gentlest possible motion rotated the whole lens as a wheel. Very gentle pressure at the bottom of the cornea expressed the lens which, in formalin solution, shows very plainly the capsule unbroken.

"With proper cocainization it would seem that no vitreous need be lost during or after this operation; certainly none was lost this time. The traumatism to the ciliary body is certainly less than in Major Smith's method, and the expression of the lens is easier than in the usual operation."

J. Stroud Hosford reported (*Oph. Soc. U. K.*, May, 1912) an identical procedure which he, being unaware of Powers' earlier operation, describes as a *new* method of cataract extraction. He says that during the previous year he had performed nine cataract extractions by this method, which consisted of entering a discision needle into the lens, and then rotating the lens on an antero-posterior axis. This caused the zonule of Zinn to be torn, after which the lens, in its capsule, could be removed without the loss of vitreous. The lens could be thus rotated either before or after the making of the section. If this method were adopted, immature cataracts could be removed, and it had all the advantages of the Smith-Indian operation, besides being safer and not so complicated. A subsequent paper on the same subject



Preparatory Rupture of the Zonula in Cataract Extraction. (Hosford.) 1. Introduction of needle through wounds and into lens, flat surface foremost. 2. Needle twisted so that flat surface helps to rotate the lens without unduly lacerating lens. 3. Rotation of lens by moving needle from first position to second position, i. e., from one angle of wound towards the other, the needle-handle being vertical. 4. To show wheel-like rotation of lens.

(*Ophthalmoscope*, Jan., 1913, p. 49) furnishes cuts illustrative of the various steps of the operation.

Bradburne believes that rotating the lens a trifle to one side with the point of the cystotome just before it emerges from the corneal opening, will often bring about the deliverance of a cataract which at first seems obstinate to deliver. No doubt this end is attained by the rupture of the weaker zonular fibers.

Delivery of the lens. Drake-Broekman says that in recalcitrant patients and where palpebral spasm is at all present, he never proceeds to express the lens without at first removing the speculum from the eye. The presence of a speculum in such cases is almost certain to be followed by escape of vitreous, for it must be remembered that any pressure exerted by the eyelids, while a speculum is propping them open, must tend to force the contents of the eyeball along the line of least resistance, which is, of course, the corneal incision. Under such circumstances, he usually removes the speculum altogether, as above mentioned, and introduces a medium-sized Desmarres' retractor under the upper eyelid. He then draws the latter upwards and well off the globe to release all pressure, and by gentle massage and judiciously exercised pressure with the pad of thumb or forefinger of the other hand, applied to the lower portion of the eyeball over the lower eyelid, and, as it were, through it, one is able most effectually and neatly not only to express the lens through the corneal incision, but to follow it up with nearly all the torn capsular matter attached thereto. This method has, besides, the advantage that no instruments are brought into direct contact with the cornea or conjunctival sac for the purpose of expression or delivery of the lens, which must lessen the chance of septic infection and injury to the corneal epithelium. He also finds that this method of removal of the lens is more efficient in cases when it is decided to extract a cataract without a preliminary iridectomy, where at times a little more pressure is necessary to overcome any resistance of an intact and possibly rigid iris. This pressure is by this method more evenly distributed over the globe and so is less liable to cause rupture of the hyaloid membrane with its subsequent extrusion of the vitreous, a complication which, he thinks, most ophthalmic surgeons are agreed should be avoided at all costs.

Rollet uses a miniature hook with which he "fishes" out the lens from the anterior chamber. He says that the crystalline must not be harpooned or spitted, but the sharp point of the (fish) hook entered so that traction and rotation may be extended upon it after the usual iridectomy and capsulotomy. He uses it very successfully, also, in luxations of the lens and has, in fact, had 17 cases of this accident which he treated by the use of the instrument. He believes that in all forms of senile cataract it ought to take the place of the usual means of assisting the birth of the lens.

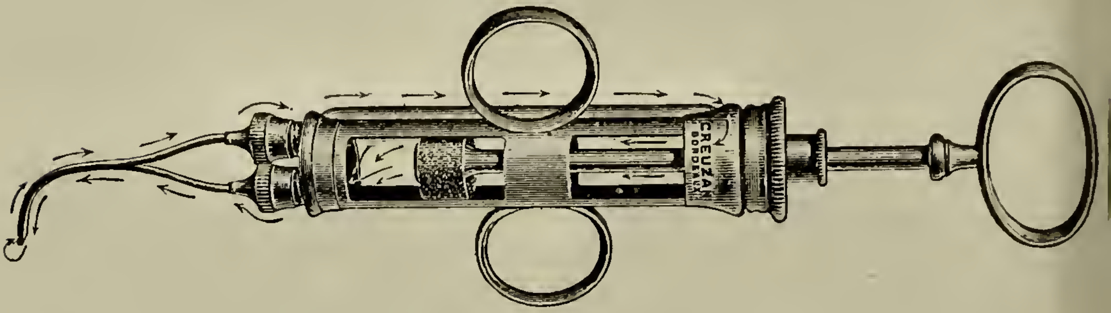
Intraocular irrigation during cataract extraction. The revival of intraocular irrigation for the purpose of freeing the anterior chamber of cortical remains and capsular tags is mostly due to McKeown, whose monograph (*Treatise on "Unripe" Cataract,* 1898) is well worth perusal. He advised it especially in immature cataract or in lenses presenting sufficient opacities to materially interfere with vision. Before expression of the lens he injects fluid beneath the capsule by means of a hypodermic-like needle. McKeown has had excellent results following this procedure and only two cases of iridocyclitis and one suppuration in 146 extractions.

Where intraocular lavage is employed as a part of the extraction it is all the more incumbent on the surgeon to insist upon an aseptic condition of the field of operation—especially of the lid margins. In the manipulation of the douche there is always a chance that microbes and toxins, if present, may float or be sucked into the anterior chamber, to work future mischief. Digital massage of the palpebral tissues upon the eyeball, combined or not with stripping the lid margins with a strabismus hook several times during the day or two preceding the extraction, is a useful adjunct to the usual preoperative technique. These maneuvres force out the unclean deposits in the Meibomian and conjunctival follicles and render subsequent attacks of iritis less likely.

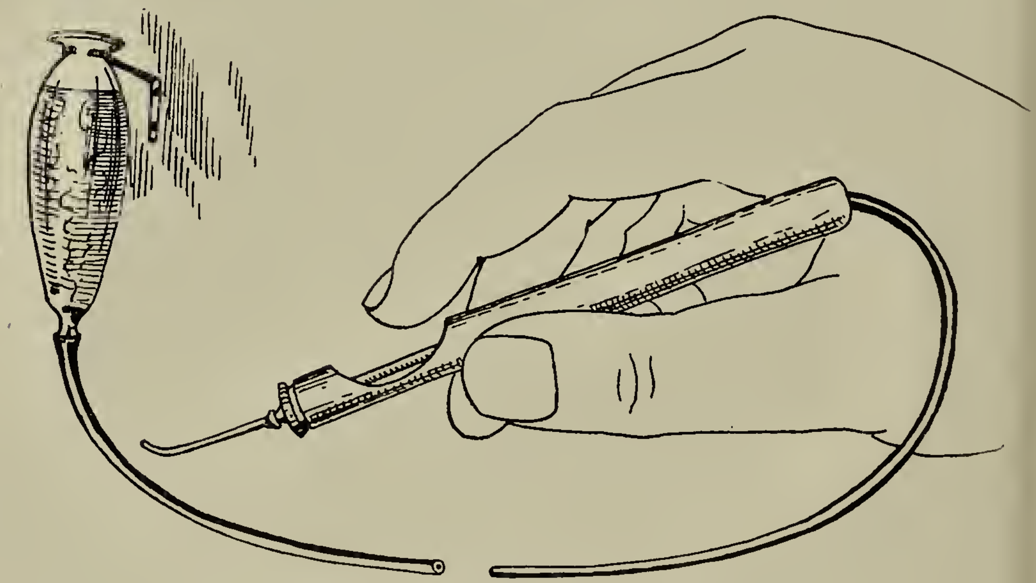
Herbert believes that, all things considered, irrigation has a decided value in removing cortex more completely, easily and quickly than would have been otherwise possible; enabling one to extract unripe cataracts that are often difficult to manage. He finds that the wound margins are left cleaner than in operations without irrigation and that this undoubtedly helps to bring about more rapid union of the wound.

"Instead of the cystotome I have used and think highly of the capsule forceps (q. v.) in conjunction with strictly clean intraocular lavage. In the hands of the average or inexperienced operator, better results in the treatment of unripe lenses will follow from the employment of these two agencies than after the Smith-Indian operation."

Lagrange and Aubaret have invented an apparently useful instrument that combines the principle of simultaneous injection with aspiration. This syringe is made by Creuzan, of Bordeaux, and its construction may be understood by consulting the figure. The inventors believe that the most careful asepsis and antisepsis of all the parts involved in the operation should be kept in mind. They also believe that the fluid employed should closely resemble the aqueous humor, should be of the same temperature as the eye and should be entirely free of the least suspicion of foreign matter. They have chosen as the irrigating fluid a mixture of 1,000 grammes of water, 6,890 grammes of chloride of sodium, 0.113 of calcium chloride and 0.221 of potassium sulphate. Used according to directions these surgeons have never seen a single case of that corneal opacity which is not infrequently observed after intraocular lavage, nor have they found any difficulty in removing most of the lenticular mass, and this without producing any immediate or subsequent irritation of the eye itself. The solution is placed in 100-gramme bottles, carefully cleansed and sterilized. Immediately before the operation the bottle with its contents is heated in a water bath of 37 degrees C. and kept at that temperature until the moment of injecting it. Paul Roethlisberger has given a complete history of this procedure, together with an account of all the appliances used.



Intraocular Irrigator of Lagrange and Aubaret.



Greenwood's Intraocular Irrigator.

as a part of cataract extraction, in washing out the anterior chamber, to the date of his essay.

So far as the writer knows the intraocular irrigator of Allen Greenwood, seems a practical and useful modification of the earlier instruments. (See the illustration.) This irrigator was devised with the object of combining lightness and ease of manipulation with the assurance that the return flow of irrigating solution from the anterior chamber should be as free as possible. To insure lightness the metal tube through which the rubber feed tube passes is made very thin, light and only about the size of an ordinary round pencil. About half an inch from one end a crescent-shaped segment is removed to allow the finger-tip to completely compress the rubber tube at that point and thus control the flow. The free return of fluid from the anterior chamber is insured by the little metal rod which can be seen in the illustration extending across the concavity of the tip like the string of a bow. When the tip is inserted into the anterior chamber, or even into the lower part of the posterior chamber, the rod serves to elevate the corneal flap and thus permit a free return of the débris-laden fluid. After the expulsion of a lens, Greenwood never makes pressure on the cornea to assist in the removal of cortical débris but irrigates for the removal of such débris in all his cataract cases. The whole apparatus may be boiled and thus thoroughly sterilized. When sterilized and filled with warm, sterile (normal) salt solution just prior to being used, the metal tube and tip may be dropped into the reservoir until the moment for irrigation arrives.

The following maneuver, as described by Skeel, seems worth recording. When the cataract knife is finally withdrawn, a grooved and bent spatula is introduced and turned transversely in the wound and a stream of warm, sterile, normal-salt-solution from a siphon irrigator directed upon the spatula at the point where it enters the wound. The fluid will follow the curve of the spatula, creating a brisk current in the anterior chamber and will flow out again bearing with it the lens matter. If the lens is in a flocculent condition, this method will remove all of it, leaving a clear, black pupil. If the lens-matter is gelatinous, or retains its structure, it will be necessary to introduce the spatula and disintegrate what remains, repeating the maneuver until it is all removed, using greater care as the spatula approaches the posterior capsule. It is rarely the case that a second operation is required when this method is employed.

The experience of a few other operators will be of value to the student. For example, Lukens (*Ophthalmology,* July, 1911.) is of the opinion that intraocular irrigation after cataract extraction will remove in a few seconds all cortex and blood, giving a brilliant black pupil and allowing a perfect coaptation of the wound for rapid healing. The patient is thus spared a tedious recovery, there being no obliterating débris to hinder vision and provoke iritis. The irrigating stream will replace a prolapsed iris in a simple extraction, and will clear the anterior chamber of blood, which sometimes obscures everything immediately following the section of the iris in a combined extraction. The procedure is easy of execution and leaves an eye from which a mushy lens has been extracted as clean as if the lens had been sclerosed. However, this ideal condition does not always follow.

The wash bulb is a type of the most successful irrigators today, owing to its simplicity. Lukens believes that the ideal irrigator should be made on the plan of a large eye-dropper, the glass part being large enough to hold the complete charge without coming in contact with any rubber, for perfect cleansing of rubber is not easy, and a perfectly clear solution is seldom seen after being expelled from a rubber bulb. To meet these conditions he has had such a giant dropper made. The glass barrel holds about six drams of liquid, the rubber bulb a little less. It is easy of sterilization by boiling, after which the rubber bulb is slipped over the barrel. The irrigator should not be filled until wanted, when it is made to draw up half an ounce or more of perfectly clear, sterile, warm, normal salt solution. The irrigator should be held upright to keep liquid from entering the rubber, or it will be no better than the ordinary bulb eye-washer. The nozzle is bent at an angle of about 45 degrees and projects a small stream, which should play against or across the lips of the wound in such a manner that a part of the stream will enter the eye and by an eddy-like motion will remove all débris from in front of the posterior capsule. The irrigator as a rule does not enter the wound, although at times the nozzle may be made to depress the scleral lip. One filling will usually suffice for one operation. This method is open to few objections.

A pledget of cotton may be wrapped around the tip of the irrigator before taking in its charge, if there be any question as to clearness of solution, thus filtering it, or the solution may be drawn up with greater ease by applying the rubber bulb to the nozzle, and when it is filled transfer the bulb to the other end.

The Gibson irrigator is constructed on similar principles, but the glass barrel is too small, holding only eighty or ninety minims, scarcely enough for one operation. The rubber bulb is disproportionately large and may aspirate the solution into itself. The different barrel and piston irrigators are hard to control, i. e., give a jerky stream; the gravity irrigators, of which the Lippincott is probably the best, have the drawback of complexity, the solution comes in contact with rubber tubing and perfect sterilization is difficult.

The contra-indications to irrigation are an unruly patient, the presentation of vitreous and in those cases where the lens has been delivered whole. The indications for irrigation are débris of any kind in the wound, or in the eye anterior to the posterior capsule of the lens.

Lukens concludes that intra-ocular irrigation after cataract extraction is an established safe surgical procedure of merit. It allows a clean toilet after a mushy extraction. The technic of such lavage should be perfect, and as simple as possible. Intra-ocular irrigation requires no extraordinary skill of the operator or assistants. Cataracts with soft cortex may be removed with nearly the same degree of safety as the mature cataract, if irrigation be available. Intra-ocular irrigation is not a routine procedure after cataract extraction, but should be available when indicated.

E Temple Smith (*Ophthalmology,* Jan. 1911.), who has had considerable experience with Bishop Harman's modification of the "undine" flask as frequently used at Moorfields, is much in favor of that simple means of intraocular irrigation after cataract extraction. The tip of the undine can be readily broken off by marking it with a file. To this end is attached any simple nozzle which is connected with the flask by 8 inches of baby's-bottle tubing. The flask, which, with nozzle and tubing, has been previously boiled, is filled through a thistle-funnel with normal saline solution. The whole apparatus can be heated to boiling point over a spirit-lamp stand, on which is placed a brass wire-gauze plate. "Usually, however, a pint of normal saline is prepared in an ordinary chemical flask. Pour a pint of already filtered water through a filter-paper into the flask, add two soloids, and boil, sealing the flask with cotton wool. This I take in my bag to the operation, and the quantity suffices for general irrigation of the eye in the way of preparation. Biniodide or boracic acid of course can be added to a portion of it if desired.

For the intra-ocular irrigation, I fill the sterilized 100 c. c. undine with the saline solution, and warm it over the lamp till a clinical thermometer registers about 100 degrees. Then by the time one is ready it is at blood heat.

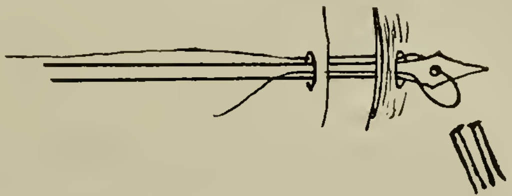
"An assistant, any person of ordinary intelligence, holds it, tipped up so that the solution flows in a steady stream, and one controls the flow with finger and thumb on the tubing close to the nozzle. The short length of rubber tubing prevents the flask being raised to an undue height. No syphon action has to be started, with, in a hot climate, the attendant trouble of perishing rubber.

"When, through an incision too small in proportion to the size of the nucleus, or from immaturity of the cataract, much cortex remains behind, one is tempted to greatly prolong the operation while coaxing it out; or, worse still, to use over-instrumentation. The eye is subjected to much less trauma and is exposed for a less time by washing out the cortex. As for the element of sepsis, I fail to see why, with so readily sterilized an apparatus and solution, this should not be quite easily eliminated.

"It is pleasing to see the flocculent cortex driven out like a flock of sheep by the circulating fluid, and the clear, black pupil which is left. And I have been impressed by the uneventful convalescence which has ensued in every case in which irrigation has been adopted. The lymph-like appearance of the pupillary area on the day after irrigation, mentioned by Maynard, is a very constant phenomenon, but always clears up in a few days."

When shall discission of the posterior capsule be done? Many surgeons, Webster Fox among the number, favor the routine employment of splitting the posterior capsule, i. e., whether there is opacity of the latter or not. In other words, it is to be mostly regarded as a prophylactic measure. The only aspect of this form of discission to be discussed here is the interval that may properly elapse between the extraction and the secondary capsulotomy. Herbert, in India, generally did the needling at the end of ten or twelve days; de Lapersonne, twelve to fifteen days; Mayweg, on the tenth day; Haab, in 2 or 3 weeks and Knapp, at the end of six weeks. But why not do it—other things being favorable—just as soon as the incision is sufficiently closed? There is little or no reaction from an early discission with a sharp knife-needle or a thin Graefe knife. Is it not better to accomplish, as a part of the major operation, the important end of insuring the best vision possible, instead of inflicting upon the patient and oneself all the disappointment, worry and anxiety attendant upon a slow decrease in vision and the ordeal of a separate, second operation? Even in the most favorable cases a discission of the capsular remnant seems to be justified in at least 60 per cent. of all cases of extraction, yet when proposed for after-cataract it always appears to the patient to be an unforeseen contingency—one that the oculist should have provided for but did not.

Conjunctival suture after cataract extraction. E. E. Maddox regards this procedure as of special value on those occasions when vitreous is lost. Two or three sutures put in carefully are also of great value in the promotion of healing, and in the prevention of septic infection. The sutures draw the cut surfaces of the cornea and the sclera into apposition sufficiently close to enable them to unite by first intention; at the same time squeezing out any vitreous that may be interposed between them. Unnecessary traction is of course to be avoided, since it would make the flap override the sclera too much.

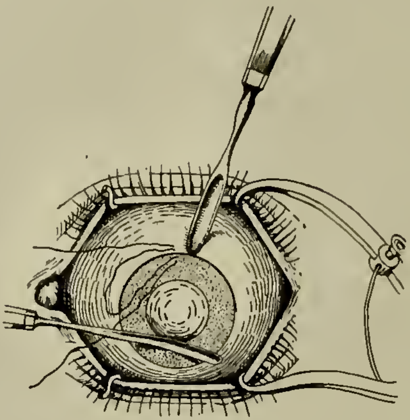


Maddox's Conjunctival Suture in Cataract Extraction.

He had a fine circular hole drilled through the head of a discission needle and finds it very useful for the purpose of suturing the conjunctiva. After transfixing the conjunctival flap, and then the cut edge of the scleral conjunctiva, with the aid of a fine straight iris forceps he next withdraws the needle a little. This slight withdrawal causes the suture beyond the conjunctiva to form a little bend quite easy to grasp with the iris forceps. This is firmly held while the needle is withdrawn, leaving the suture ready for tying. The needle should be slightly curved on the flat. After an ordinary extraction the conjunctival flap adheres so soon that a suture is unnecessary, but in those rare cases which are performed under chloroform, it is of great advantage, as affording greater security in the event of vomiting taking place. Patients, also, who are addicted to sneezing and coughing, are always safer for a conjunctival suture.

Suturing the cornea. This method is intended to prevent extrusion of any portion of the ocular interior after the section has been made. H. W. Williams, of Boston, was the first (*Roy. Lond. Oph. Hosp. Reports,* Vol. VI, pt. 1, 1867, and *Archives of Oph.,* Vol. 1, 1869, p. 102) to propose a corneal suture after extraction of the lens. Since then Chisholm (*Richmond Med. Jour.,* Vol. 4, 1867, p. 307), Suarez de Mendoza (Suture de la cornée, *Soc. Fr. d'Ophtal.,* Vol. VII, 1889, p.

30), C. H. Williams, Vacher, Kalt (Suture de la cornèe, *Arch. d'Ophtal.*, Vol. XIV, 1894, p. 639), in addition to other operators, have improved the original method so that it is of value in certain cases. Kalt thus describes his operation, which is illustrated herewith: After cocainization and disinfection one passes through the cornea a needle (which should be very small, fine and sharp) armed with the finest linen suture. It is of great importance that the point of the needle should not reach the anterior chamber or pierce the whole thickness of the cornea. It should pass into and out of the substantia propria



Extraction of Senile Cataract.

The employment of the corneal suture. (Kalt).

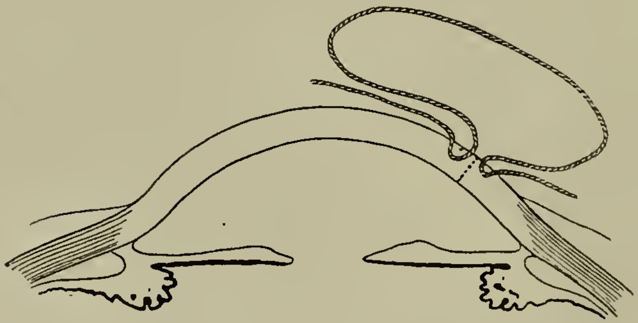


Diagram of the Corneal Suture of Kalt.

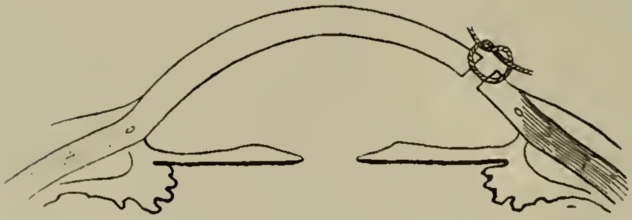


Diagram of the Corneal Suture of H. W. Williams.

on one side of the proposed wound, then obliquely through the opposite border of the limbus and, in the same way, through the scleral tissue, just as in making a muscular advancement. The loop is then drawn to one side so as to clear the incisional line. When the loops of thread are placed (as shown in the figure) the corneal section is completed, care being taken not to cut the threads, and to place the incision exactly so that it will be midway between the entrance and exit of the corneal and scleral stitches. The operation is then completed in the usual fashion and the threads tied in a single knot.

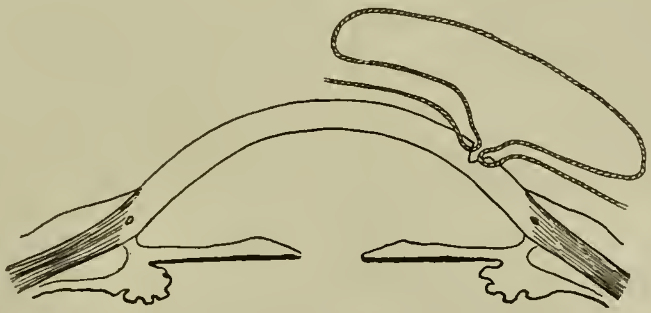


Diagram of the Corneal Suture of de Mendoza.

The Editor would like to suggest, in this operation, instead of silk or other threads, that fine four- or five-day catgut sutures be employed. The main advantage of these is that they are absorbed and do not, like threads, have to be removed (an act that sometimes proves difficult), they do their duty effectively and remain *in situ* long enough to keep the parts in apposition.

Ellett (*Jour. of the A. M. A.,* Sept. 21, 1912.) believes that the surgical results are much better in those cataract extractions where a corneal suture is employed. He thinks that there is a speedier convalescence, that the pupil is clearer and that there is less tendency to secondary cataract. The early closure of the wound permits the patient to get out of bed sooner; to have the eye not operated on left uncovered; while it also is a safeguard against infection.

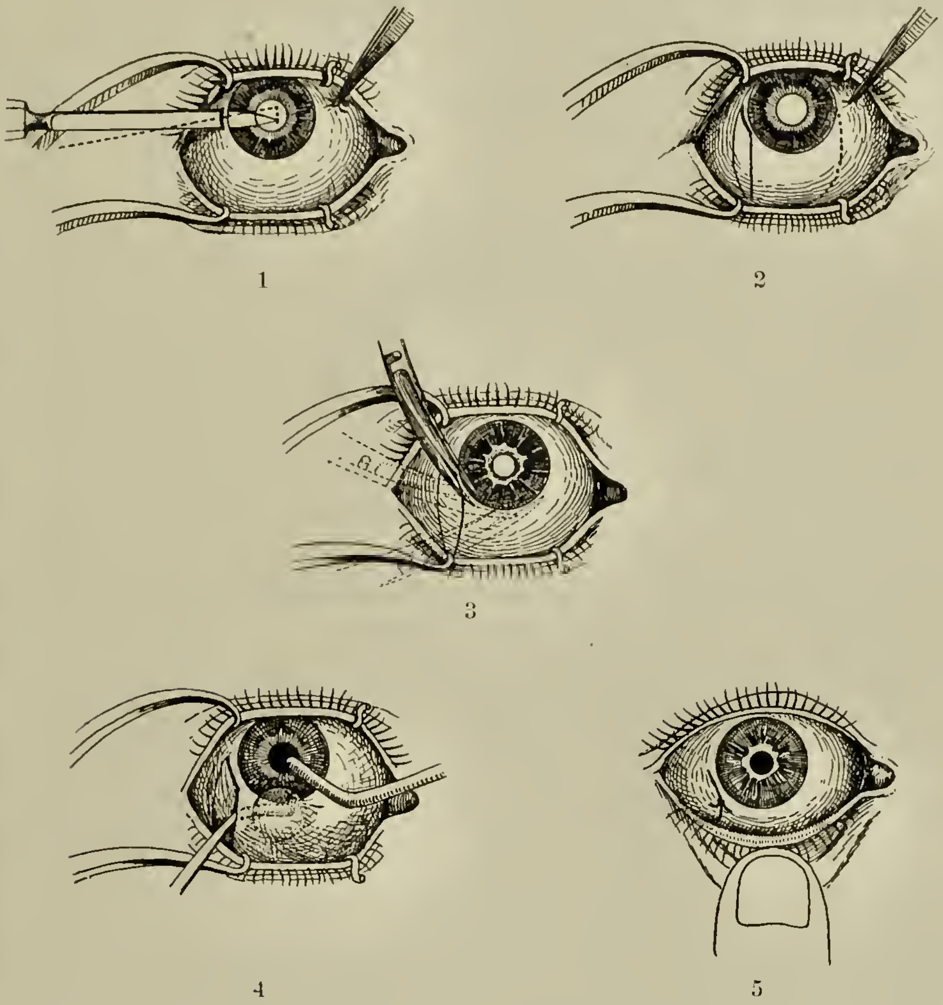
Suturing of the cornea in a cataract operation ought, according to Alonso, to be an exceptional proceeding; for although it facilitates cicatrization and avoids hernia of the iris, yet it deforms the cornea and produces opacity thereof. He believes that the suture is indicated in certain capsulo-lenticular cataracts, with an opaque and thickened capsule, when, after extracting the lens, the thickened capsule remains and exposes the eye to infection from delayed union. A previous stitch in the cornea will allow the capsule to be extracted and the lips of the wound to be approximated immediately. In trembling, subluxated cataracts, with zonular alterations and in cataracts with hypertension, small anterior chamber, paretic iris and dilated pupil it is also indicated. In such cases hernia of the iris is avoided as well as escape of the vitreous humor. The suture should be fine, aseptic, close to the limbus and placed so that it will involve the corneo-scleral parenchyma. The threads should remain 5 or 6 days.

W. H. Bates (Suture of the Cornea After Removal of the Lens, *Archives of Ophthal.*, Vol. 27, 1898, p. 181) has furnished a complete account of the work done by previous observers, together with a comparison of lens extraction from the rabbit's eye. Bates concludes that the use of sutures to close the wound in the operation for the removal of the lens in man is a valuable improvement in the technique.

Moret (*La Clinique Ophtal.*, April, 1913) strongly advocates the Kalt method of corneal suture and believes the entire procedure does not require a minute of added time, while the advantages are many, among them: (1) Safety from prolapse of the iris in simple extraction, and incarceration of the iris angles in the combined; (2) ability to clear the débris from the pupillary area without loss of vitreous, thus avoiding secondary operations even in immature cataract; (3) possibility of using a cystotome without danger upon a posterior calcareous capsule; (4) much less danger of infection, especially when lachrymation and conjunctivitis are present; (5) healing much more rapid, without fear of everting the flap; (6) the patient need not be kept quiet after the operation.

A modification of Kalt's suture is also proposed by V. Ribas (*Archivos de Oftalmologia*, December, 1911). Both sutures are placed in the conjunctiva instead of in the cornea, one being introduced in what is to constitute the conjunctival flap in a direction parallel with the corneal limbus; the other in the conjunctiva beyond the flap. The method is easier than that of corneal suture, and is less likely to lead to risky infections. Its only inconvenience is that it calls for more care in cutting the conjunctival flap, in order not to divide the thread. The cutting of the conjunctival flap may be facilitated by a previous subconjunctival injection close to the superior aspect of the limbus. When iridectomy is necessary, the suture may be used to draw the flap forward out of the way of the iris scissors.

The chief objection to the use of conjunctival and corneal sutures is, as Melville Black has pointed out, that something like a second operation must be endured by the patient and carried out by the surgeon. For their removal the eye must be prepared for operation in the usual way, anesthetized, a speculum introduced and instruments employed upon the globe.



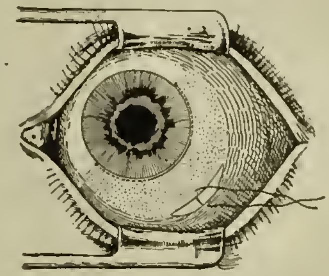
The Various Steps of the Czermak Sub-conjunctival Operation. (After Czermak.) 1. Puncture with the large Graefe knife. 2. Conjunctival, inner incision along the dotted line. 3. Incision of the cornea with scissors. 4. Escape of the lens into the conjunctival pouch. 5. Final result. Conjunctival suture.

Czermak's subconjuctival extraction. This operator used a large knife with which he entered the anterior chamber at the temporal end of the horizontal corneal meridian, the puncture being made through the conjunctiva well beyond the limbus. (See the figure.) It is then passed to the center of the pupil and the point, acting as a cystotome, opens the lens capsule. It is then entirely withdrawn. The operator now makes another incision through the conjunctiva downwards about 15 mm., and undermines it a little beyond the inner end of the horizontal corneal meridian. Care should be exercised not to cut through the conjunctival flap, which is now raised by means of forceps in the hands of the assistant. The surgeon, at this stage of the operation, introduces into the anterior chamber the posterior blade of a pair of blunt-pointed and curved scissors. He then divides the cornea around the margin subconjunctivally, as far as the first incision. The operator now expels the lens by making pressure over the upper part of the cornea, at the same time depressing the posterior lip of the wound. If the original opening in the anterior capsule, made with the point of the cataract knife, be insufficient to permit of the escape of the lens, a cystotome is brought into play. The cataract now glides into the conjunctival pouch, from which it is easily removed; and the wound in the conjunctiva is closed by a couple of sutures. The accompanying figures will further serve to elucidate the foregoing description of this operation.

At the close of the operation eserin solution is instilled and a protective bandage applied. Czermak advises that an hour before the operation a dose of trional or veronal be given and that the patient be kept as quiet as possible after the operation.

Subconjunctival extraction of cataract—other methods. Dimmer has modified the Czermak operation and somewhat simplified it. He first tattoos with Indian ink the operative field about the limbus and conjunctiva, as represented in the accompanying cut. The conjunctiva is incised down and out for 8 mm., and the same distance parallel to the sclero-corneal junction. It is then undermined over the whole area outlined by the tattooing. The subsequent corneal incision is divided into three stages. The middle third is first opened by means of a keratome and this incision is extended with scissors on either side, as in the Czermak operation. In addition Dimmer now (Eine subkonjunktivale Methode der Starextraktion, *Bericht der Ophthalm. Gesell.,* 1907, p. 218) places a suture in the conjunctival flap by which he raises it, with the attached cornea, opens the capsule and expels the cataractous mass. The thread is then tied to close the cut in the conjunctiva.

Bajardi also does extraction of cataract by a subconjunctival method that much resembles that of Czermak, except that the incision is made entirely with a Graefe knife. He makes his sclero-corneal incision upwards to include from one-third to two-fifths of the circumference, the puncture and counter-puncture being ½ mm. within the conjunctival circle. The conjunctival flap above is cut from 12 to 15 mm. broad. He then makes an iridectomy, opens the capsule with a cystotome or with a cystotome forceps; then, with a Daviel spoon beneath the conjunctival flap (applied at the edge of the wound) he makes gentle pressure backwards and expresses the lens by means of another spoon bearing upon the ciliary region below. The subsequent acts are the same as in the ordinary operation.

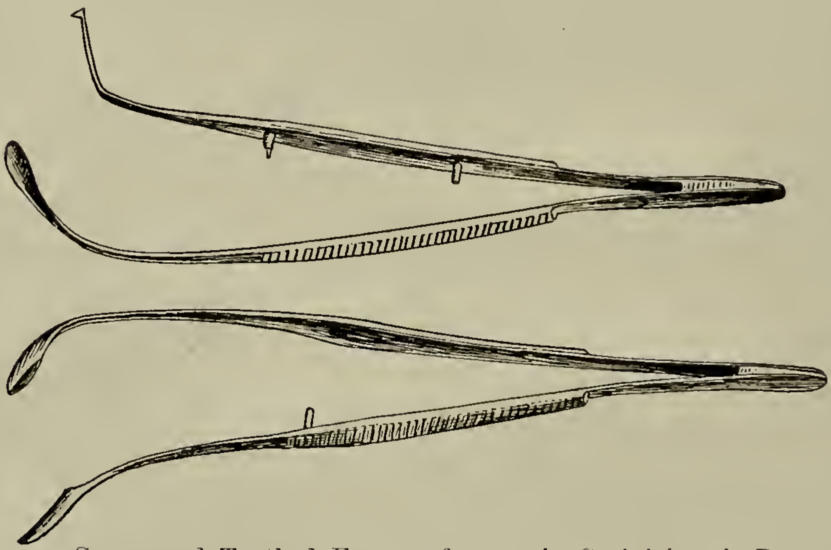


Dimmer's Subconjunctival Method of Senile Cataract Extraction.

Cluckie describes an operation which closely resembles that of Czermak. The extraction proceeds as usual to a point where there is left a connecting flap or bridge between the cornea and the conjunctiva, about 4 mm. broad. Instead of completing the corneal section in the usual fashion, the Graefe knife is carried farther up under the bulbar conjunctiva for from 10 to 12 mm. and is then withdrawn without cutting through the conjunctiva. We thus have a corneo-conjunctival bridge, which may be broad or narrow, but the broader and longer the conjunctival attachment to the cornea the greater the chances of success and speedy recovery. The object in having a large corneo-conjunctival band is to allow of sufficient bulging or gaping of the wound to take place, so that when pressure is applied by a Daviel's spoon on the lower part of the cornea the wound opens sufficiently to allow of the exit of the lens and to close immediately pressure is withdrawn. If the surgeon desires to perform iridectomy at this stage it is best done upwards and inwards; the capsule of the lens may be ruptured either before or after the iridectomy from the temporal side. By these means the operator will feel that he has complete command of the eye, no matter how nervous or restless his patient may be.

George Crainiciann. as the result of animal experimentation, suggests extraction of the cataract through a retrociliary incision and pictures the instruments (see illustration) both of which, forceps-spoon and toothed-forceps, he has used for the purpose. He first communicated this idea to the *Roumania Spitaluk,* 1897, p. 44. Of course, it remains to demonstrate its value on the human eye.

After-treatment of cataract extraction. E. E. Maddox generally prefers a guarded open treatment, but when dressings have to be applied resorts to the expedient of laying a small salt-spoonful of powdered boric acid in the hollow between the closed eyelids and the nose. A circle of wet lint is laid upon the powder and this again covered with gutta percha tissue, with such upper dressing as the case requires. The flow of tears keeps the eye bathed in a saturated solution of boric acid, which militates against septic infection. This procedure, he adds, has nothing in common with that of Haab, who obliterates the canaliculi with iodoform powder, to mechanically prevent exit of microbes from the sac when there is a suspicion of dacryocystitis. There is nothing to contra-indicate the employment of both procedures should they appear desirable; the iodoform before closing the eye, and the boric powder after it.



Forceps Spoon and Toothed Forceps for use in Crainiciann's Retrociliary. Cataract Extraction.

Wicherkiewicz prefers the "open" method of treating operative wounds of this character. He uses a simple protective shade, made of paper, which is kept in place by adhesive material applied to its borders. This dressing may be removed and renewed as often as is necessary to make applications to the eye itself.

The normal healing of wounds after cataract extraction has been studied histologically by Henderson (*Ophthalmic Review,* May, 1907.) who made sections of 33 aphakic eyes in which healing was progressing normally. A vertical incision through the cornea is followed by a greater retraction of the anterior and posterior than of the central corneal layers, so that the wound-margins show two curved surfaces meeting at the middle. Irregularities of these surfaces, due to sawing motion in the section, may give the wound track a notched, wavy, or step-like form. There is also a tendency for the corneal flap to override the peripheral scleral lip and cause further gaping. This is due to the extensive incision, allowing the corneal lamellæ to be released from their normal tension, and is more marked in an oblique cut. In a purely corneal incision, mediate union is first brought about by a fibrinous exudate from the corneal lamellæ or more probably from the aqueous, causing agglutination about the center of the incision.

Later on the surface epithelium and posterior endothelium grow down and proliferate till they meet and cover the lips of the wound and the fibrinous plug. This generally takes two or three days, but may be much delayed in apparently uncomplicated cases by some individual factor in wound repair. When there is excessive gaping, corneal epithelium may make its way into the anterior chamber, and even block the iris-angle. The corneal elements play no part until more than two weeks after operation, when they grow, compressing the fibrinous plug, and finally coalesce completely, causing firm and permanent cicatrization two or more months later. In limbal or scleral incisions, the place of the corneal epithelium and endothelium is taken by episcleral connective tissue and vessels derived from the conjunctival flap. This does not take place until after the third day. Later these cells are replaced by scleral tissue cells. The resulting cicatrix is broader and more distinct than in corneal section. This mode of healing also explains post-operative astigmatism, which is more marked in the peripheral flap operation than after linear incision, the intercalated tissue from the limbus acting as a wedge.

Some of the accidents and complications of senile cataract extraction and their treatment. Although Ellett has treated some parts of this subject under the caption **After-treatment of ophthalmic operations** in this *Encyclopedia* it will, perhaps, not be out of place to reconsider a few of them here.

It goes without saying that the cause of most of the accidents and complications that arise during and after cataract extraction are the result of defects not solely in the manipulative skill and to carelessness on the part of the surgeon, but quite as often in lack of control on the part of the patient. Another cause of trouble is the undesirable local conditions referable generally to immaturity of the cataract, the septic condition of the eye or its appendages, or to lack of the usual aseptic precautions. Whatever has determined the unfavorable outcome of an operation it is of importance to learn whether it has resulted from ignorance, carelessness or lack of thought on the part of any of those specially involved in the extraction.

Age in cataract extraction. *Old* people must not be confused with *aged* people, thus, a man of 65 may be free from physical defect, whereas it is rare to find a man of 80 whose physical activity is not reduced to a minimum, a slight emotion or change of habit being sufficient to upset his equilibrium, and the smallest shock being enough to end his life. Trousseau (*Clin. Ophtal.,* Oct., 1909) thinks that in practice it is impossible to determine by his age alone that a man has become old. One must also remember that it is not fair to refuse even a very old man the pleasure of seeing, if only for a few months—all depends on the patient. Knowing what may happen, operation should only be undertaken with special precaution. The traumatism of the actual operation is so slight that it can be safely disregarded. If the patient is suffering from an affection which may kill him soon, operation must be refused; and one must not forget that in very old people rapidly fatal illnesses may happen, of which the cause may be anything but obvious. Trousseau operated on a man æt. 85, who died four or five days afterwards of intestinal obstruction—*apparently* he had been in good health.

Cerebral affections, however slight, are a contra-indication to operation. Precautions must be extreme where there is pulmonary congestion.

The urine must in all cases be examined qualitatively and quantitatively—the latter being regarded by Trousseau as the more important of the two; in fact he operates without fear on albuminuric or diabetic subjects, but not if urine is passed in small quantity.

Dangers to old patients—

(*a*) During operation } local dangers.
(*b*) After " } general "

(*a*) The same dangers as in all subjects, but tending more to hemorrhage either from iris, or after expulsion of lens from collapse of globe in old people. Trousseau thinks cocain favors the latter condition, and uses it sparingly on that account.

(*b*) (1) Prolapse of iris, because of restlessness, or cough. (2) Slow healing of wound; two to four weeks in some cases, owing to defective vitality. (3) Secondary hemorrhage more common in the old. (4) After first dressing an acute conjunctivitis may appear, in spite of aseptic precautions. The pus does *not* contain known virulent microbes, *e. g.*, pneumococcus, but in spite of this may cause iritis, infectious irido-choroiditis, and even panophthalmitis.

Delirium generally appears from the first to the third night after operation, is variable in form, from slight loss of knowledge of place, time and events, to furious delirium. It may indicate pulmonary congestion or uremia, but is generally due to want of orientation, and to being bandaged up.

It generally yields to taking off the bandage and putting a pad only on the operated eye. The preoccupation due to the operation, a change of habits and abode, the relative isolation, all work on the mind of the old man, and this with complete darkness excites him, and delirium results. Trousseau is opposed to a dark room as it is too depressing, and he only bandages one eye in nervous patients.

During the first 24 to 48 hours cerebral hemorrhage or diabetic coma may supervene and may be due to mental shock of operation combined with previous ill-health. Pulmonary congestion and even pneumonia are too frequent to be due to chance, and are almost always due to lying on the back. If the patient is a little delirious, tongue dry, and dry râles heard over the bases, he must be raised into a chair and kept there day and night. The bed is the danger in old people.

Fromaget and Trousseau have called attention to operative uremia, a condition only seen in old people, and not necessarily in cardiac and kidney cases. Delirium comes on 24 hours after operation, the patient may vomit a little, and the quantity of urine suddenly falls to 200—250 cc. till anuria may come on and death ensue. Hence the value of quantitative examination, which should be done daily during treatment. If any diminution occur, Trousseau orders a milk diet, injects caffein and gives theobromin. He considers it due to vasomotor spasm in the vessels of the kidney. (E. H. Jones, *Oph. Review*, Aug. 1910.)

In the preparation of the patient it is well not to instil too much cocain. Four or five drops applied to the conjunctival sac, at two or three minutes interval, are quite sufficient. Repeated and superfluous anesthesia reduces the tension of the globe, encourages bleeding from the conjunctival flap and may interfere with the healing of the wound.

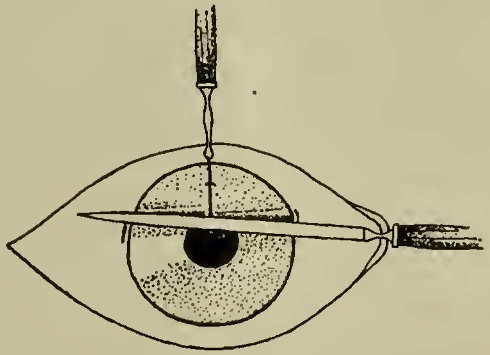
Should the knife, or any instrument about to be used upon the eye, touch the skin, cilia or any other unsterilized part or object, it should immediately be exchanged for a clean instrument.

It occasionally happens that after the puncture or counter-puncture the surgeon discovers that he has inserted his knife upside down. It will be found that this accident is variously treated by different authorities. Knapp (Norris and Oliver, *System of Diseases of the Eye,* p. 800) recommends that the knife should be turned on its long axis so as to entirely reverse its position, and thus to continue the section. (This exasperating accident happened to me once when using a long and quite thin knife on a deep-set globe, and I was able to follow Knapp's suggestion. On the other hand I do not see how it is possible, with a Graefe knife of average thickness, to accomplish this feat without considerable loss of vitreous and much damage to the cornea. On the whole it is better to withdraw the knife and wait until the original wound has healed.)

Melville Black has invented a knife intended to meet this contingency. It is the usual cataract knife with a blunt point which is inserted into the original corneal opening with the proper edge up and the section completed.

Removal of corneal epithelium. Since the introduction of adrenalin and cocain in extractions it is not uncommon after the expulsion of the lens to note corneal areas that have lost some of their protective covering. Such result is undoubtedly due to the action of these remedies—especially of cocain—in softening the anterior epithelium so that even stroking the cornea with the delivery spoon suffices to detach portions of it. As a rule no serious consequence follows this accident, yet it cannot tend to the welfare of the eye and should be avoided by using no more of the local anesthetic than is necessary, by instructing the patient to keep his eyes closed during its action and by avoiding too much pressure on the cornea during the lens delivery.

Treatment of the iris that has fallen in front of the knife. In simple extraction the iris occasionally falls in front of the knife. This complication generally arises as a result of improper manipulation of the instrument and usually when the cutting plane has been altered. In most cases it is best to proceed with the operation even though, as a consequence, some irregular form of iridectomy be done. Jameson advises that in the operation of simple extraction, when the iris falls in front of the knife, and ordinary manipulative methods fail in replacing it, a sharp, slender, javelin-pointed needle be made to pierce the cornea, as shown in the figure. Once in the anterior chamber the needle can be swung against either border of the engaged iris or, the point being passed directly to the lower border of overhanging iris, it is lifted over the edge of the knife. This accomplished, the needle is pushed behind the knife so that it is interposed between the knife and the iris. The operator now proceeds with his incision and withdraws the needle immediately the iris is free. When the accident occurs, the fixation forceps is quickly handed to the assistant and the operator lifts the cornea on the flat of the knife, which is slightly rotated, and the needle manipulated as above described. The puncture of the cornea, after the chamber has been opened, is not always as easy a procedure as it would seem, and this method is not adaptable to cases of collapsed and flaccid cornea. When carefully performed without laceration, the puncture does not interfere with healing, and when successfully done, is preferable to a wounded, lacerated iris.

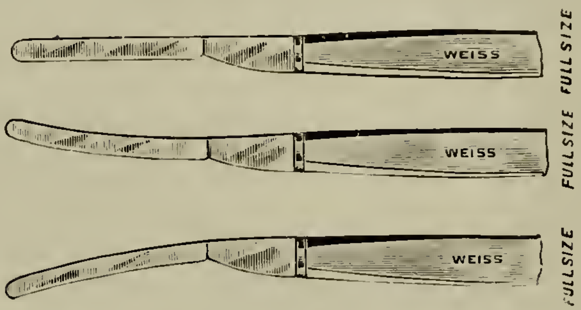


Jameson's Method of Replacing the Iris that has Fallen in Front of the Knife.

The split cornea. When the point of the knife is not properly entered to make the puncture, this accident, as before mentioned, is very likely to happen. Of course, it endangers the success of the operation and invites all kinds of subsequent complications. Fortunately, the operator will notice the mistake that he has made and will be able to withdraw his knife before the anterior chamber is entered. Another form of "split cornea" occurs when the counterpuncture is made. The point of the knife should be entered a little back of the apparent limbus as the light refraction gives it the appearance of being thrust farther forward than it really is. When a badly placed section is made in the cornea the wound edges do not heal kindly or properly. Not only is there much operative astigmatism but a wound infection of greater or less degree is likely to follow.

The operator should, before taking the first step, carefully review the various stages of the proposed procedure and endeavor, as much as possible, to recollect the idioms of cataract extraction. He should, as the result of experiment, both on the lower animals as well as on human subjects, observe the rules already laid down, especially for a uniform and proper corneal incision.

Stabbing the iris. Occasionally the operator thrusts the point of his knife into the iris while pushing that instrument through the anterior chamber. Generally, this can be remedied by withdrawing the knife a mm. or so and disengaging it. He will then be able to make the counter-puncture without loss of aqueous.



Desmarres' Secondary Cataract Knives, Straight, Concave Edge, Convex Edge. For enlarging a too small corneal incision.

Incomplete sclero-corneal incision. Experienced operators are generally conscious that they have not made the opening in the eyeball large enough for the extrusion of a large lens as soon as the corneal incision is complete, but beginners may not be aware of that fact until an attempt is made to extract the lens. When the lens cannot, with moderate pressure, be removed through the opening, it is better to enlarge it with scissors or Black's blunt-pointed knife (q. v.) than to bruise the tissues and detach soft matter by prolonged efforts to expel the cataract.

With Desmarres' secondary cataract knife, also, the original incision may be successfully widened. (See the cuts of these.)

Collapsed cornea. When too much cocaine has been used, or in aged or weak subjects, a falling in of the cornea may occur, sometimes before the expulsion of the cataract. At this stage of the operation it need not embarrass the operator, but if the collapse happen after the removal of the lens a good plan is to fill the contracted chamber with warm, sterile, normal-salt solution, and this step may be carried out as a part of the irrigation of the anterior chamber, after a preliminary removal of cortical remains, by stroking the cornea with the back of a spoon.

Collapse of the sclera without loss of vitreous is rather a rare incident in cataract extraction. Terrien, in his *Surgery of the Eye,* gives a short note of two cases. Le Roux, in a recent number of *La Clinique Ophthal.,* reports a case and Sirieys details two cases. In both of the last, just after completing the incision, the sclera was found to be collapsed, so that it was impossible to extract the lens by the ordinary pressure maneuver. The loop was accordingly passed behind the cataract and delivered. There was in neither case any loss of vitreous, and both patients made a good recovery with useful vision.

Air in the anterior chamber. This need not be a source of alarm; indeed entirely too much space is given in text-books to such an accident. The only importance that seems to attach to it is the possibility of the bubble, or bubbles, carrying infective matter into the anterior chamber. By using the simple irrigator I do not find it difficult to expel the air bubbles, and much prefer this method to making attempts to squeeze the air out of the anterior chamber by means of a spoon.

Hemorrhage into the anterior chamber. When the conjunctival flap is made too large there is always more bleeding from the severed sclero-conjunctival vessels than when the flap is properly cut. This accident, which not infrequently happens, is responsible for the most objectionable factor in operations done with a conjunctival flap. Undue bleeding is also a result of prolonged, excessive cocainization and the too early use of suprarenal preparations. Better avoid the use of adrenalin until the last, or second last, drop of cocain is instilled. Then the hemostatic effects on the eye will be obtained at the proper moment, and there will be less enlargement of the blood vessels which almost always follows the use of these styptics.

As a choice of evils it is better not to manipulate the lips of the wound too much in an effort to expel blood from the anterior chamber. As before mentioned, after making the conjunctival flap, the whole eye should be gently flooded with warm boric acid solution, and the blood, in all its forms, coaxed out of the eye with dabs of cotton and by means of the anterior chamber syringe. A small quanitity of blood remaining in the anterior chamber, as a rule, soon becomes absorbed and does little harm except to obscure, for the time, the intraocular field of operation. Sometimes, however, it becomes organized and forms one variety of after-cataract. In that case the use of atropine is indicated to prevent posterior synechiæ, and dionin to promote absorption of the deposit.

An insufficient cystotomy often a serious matter. This defect in cataract extraction may generally be prevented by using a very sharp, almost needle-pointed cystotome and entering it carefully but firmly. Sometimes, even with the greatest care, the surgeon may not discover that he has to deal with an unusually tough capsule until the lens refuses to be expelled from its bed. In such cases it is best not to make too many efforts at cystotomy, but to use a pair of capsulotomy forceps provided with very sharp teeth. The instrument of Couper or Tooke (q. v.) will be found effective. If these fail then the extraction should be attempted as in the operation in the unruptured capsule; although a hook or some other traction instrument may also be used—but with care.

Button-holing the iris. Even a careful operator, in his anxiety to remove as small a portion of the iris as possible, may find after the use of the scissors that he has made a "button-hole" opening in that membrane. This generally follows the seizure of the iris too near its base.

The iridectomy can still be carried out by passing in a Tyrrell's hook, drawing out the little band of uncut tissue and snipping it with the scissors. Herbert advises that:

"The narrow strip of tissue may be readily hooked upwards by the cystotome (held in the right hand) after the capsulotomy has been done. If very narrow it tears readily; otherwise the loop is released, and the forceps and scissors are again taken up. The forceps are used so that one blade passes down in front, and the other, generally more or less embedded in soft lens matter, behind the band. This will still be found lying near the wound, retraction being interfered with by the sticky lens substance. The points of the forceps being closed beyond the band, the latter may then be readily hooked up and cut away. Or if the eye be very unsteady the forceps may be dispensed with. The left hand may be usefully employed with the curette or expressing hook. Pressure is applied at the lower edge of the cornea, as for expulsion of the lens. The wound is thus forced open, and the little band of iris stretched and carried forward on the presenting lens, either into the wound or near it, so that it may be easily cut with scissors. Usually the strip of iris may be made to present sufficiently well for the scissor blades to be applied transversely, snipping off lens substance together with the iris. Should by chance a long tag be left attached to one angle of the coloboma, this shrinks afterwards, but forms a posterior synechia."

Partial or complete dislocation of the cataractous lens during the operation for its removal. Cataracts affected with some degeneration of their cortex, nucleus or capsules, or, those with a diseased zonula, after the corneal section may sink into the vitreous, stick to the posterior surface of the cornea or become dislocated behind the iris. It is difficult to lay down rules for the management of these unusual excursions of the lens during its extraction, but the use of Taylor's vectis, a capsule hook or the wire loop of Weber will be found efficacious in most cases. Bourgeois has described his method of removing the ordinary cataract by means of a fish-hook-like instrument, and a similar procedure is about the best for dragging out of the anterior chamber these errant cataracts. When they sink deep into the vitreous the condition is a more serious one and the wire loop should be used at once, in the hope of reaching them before it is too late.

Immediate prolapse of the iris. Immediate prolapse often, if not generally, means tags of capsule or vitreous between the lips of the wound, as L. Müller (Beiträge zur-operativen Augenheilkunde, *Klin. Monatsbl. f. Augenheilk.*, 1902, p. 358) has shown. A fine, fibrillar, capsule remnant may hold the iris in this fashion and elude the curette or spatula used to free it.

Swanzy (*Diseases of the Eye*, 6th Ed., p. 373) recommends the routine search for such capsular, vitreous or cortical remnants. He passes the iris forceps into one angle of the incision and carries it along the whole length of the wound, repeatedly opening and closing it for the purpose of engaging and drawing out any tags that may be found. When caught, these are pulled out and cut off with scissors. Swanzy, in this way, has found capsule in the wound in about 25 per cent. of all cases.

Atropine irritation, dermatitis and conjunctivitis. This idiosyncrasy against belladonna shows itself in swelling of the conjunctiva and roughness of the palpebral skin. It is never accompanied by pain but generally by some itching and ocular discomfort. It is commonly observed several days after the first instillation of the drug, and may be associated with considerable thickening of the skin surface and a sero-mucous discharge from the eye. It is an alarming sign to one who has not previously encountered it but is not, fortunately, as serious a complication as it appears. The form of the mydriatic should be changed to duboisin or hyoscin, the dose reduced to the minimum and a simple ointment applied to the roughened lids.

Loss of vitreous before, during and after extraction of the lens. The revival of the operation for extraction of cataract in its capsule led Drake-Brockman (*The Ophthalmoscope,* March, 1906.) to look more critically into the subject of vitreous loss accompanying or following various forms of lens removal. A record of cases extending over many years deals with, firstly, the 3-mm. flap operation with iridectomy, and secondly, the 3-mm. flap operation without iridectomy. Cases are taken consecutively as they are recorded:

1. Pagenstecher's Operation.			
Recoveries	Good vision	194	or 66.21 per cent.
	Fair vision	83	or 28.32 per cent.
Failures		16	or 5.46 per cent.
	Total	293	
Loss of vitreous		84	or 28.67 per cent.
2. 3 mm. Flap Extraction with Iridectomy.			
Recoveries	Good vision	191	or 65.18 per cent.
	Fair vision	84	or 28.65 per cent.
Failures		18	or 6.81 per cent.
	Total	293	
Loss of vitreous		17	or 5.80 per cent.
3. 3 mm. Flap Extraction without Iridectomy.			
Recoveries	Good vision	220	or 65.08 per cent.
	Fair vision	60	or 20.81 per cent.
Failures		13	or 4.43 per cent.
	Total	293	
Loss of vitreous		3	or 1.02 per cent.

The escape of vitreous at any stage of cataract extraction generally means rupture of the capsule, hyaloid membrane or suspensory ligament, combined or not with a fluid vitreous and increased ocular tension. The pressure that excites it may, however, be external, such as by the lids, fingers, dressings or instruments. Sometimes the contraction of the straight muscles may be responsible for the accident. Sometimes the vitreous may be present between the lips of the wound without actually entering it or without any subsequent escape of the fluid.

Loss of vitreous most frequently attends or follows the delivery of the lens, although it may take place as soon as the opening in the eyeball is large enough for its exit. It rarely occurs during the healing of the wound or after it has closed.

If the counter-puncture be too deep, or too peripheral a section has been made, the zonula is deprived of its usual support and loss of vitreous is all the more probable. Prominent eyes, as in high degrees of myopia or exophthalmus, are more liable to this accident than those normally set, mainly because the lids, in contracting, have a greater purchase upon the globe.

The immediate causes of expulsion of the vitreous are spasm of the orbicularis brought about by any of the factors just mentioned that make the patient ''squeeze up'' the eye; too marked use of the fixation forceps; pressure or dragging of the capsule forceps or cystotome; a prolonged or too rapid section; an unexpected upward rotation of the eye when an instrument is in the anterior chamber; too much force employed in an attempt to expel cortical matter or capsular remnants; the difficulties already mentioned in attempting to cut through tough capsules, etc.

Ray (*Jour. Am. Med. Assoc.*, July 6, 1907.) finds much diversity of opinion as to the effect and prognostic significance of this accident. In his experience, one of the most frequent causes is an improperly fitting or badly constructed speculum. Resort to a lid retractor immediately after removal of the lens would obviate it in many cases. Loss at the time of operation adds to the danger of primary infection, irrespective of the quantity lost, but depending on the care used in the preparation of the field, while the danger of iridocyclitis during the stage of healing is always greatly increased. Hyalitis with closure of the pupillary space is a frequent result of the cyclitic irritation. Floating opacities develop and may organize into bands which cause detachment in later years. Attention was called to the factor of intractability of the patient, and stress laid on the importance of a good speculum and the advantages of removing it at an early stage of the extraction operation. When the vitreous is fluid, loss seems to be less deleterious than otherwise, as the prolapsed portion does not separate the lips of the corneal section and there is no increased danger of infection of the wound. The remote effects are always worse than the immediate sequelæ. A small bead of vitreous may be snipped off with good results, but often there is repeated prolapse. This interferes with the replacement of the iris, the removal of cortical remnants and the toilet of the anterior chamber and wound, and in this way, by preventing a complete and tidy operation, does the most mischief. It may even prevent extraction of the lens, due to its sinking into the depths of the eye when there is sudden prolapse of vitreous early in the operation.

Of course, the wisest plan is to prevent, if possible, this accident by avoiding all those conditions that predispose to or directly cause it. When, however, the accident has happened it is advisable to cut away the projecting tissues with scissors. Even if this does not bring about an immediate adaptation of the wound margin it generally assists their readjustment within a short time. In performing this simple operation it should be done as quickly as possible, while the patient is looking straight ahead or upwards; a downward fixation encourages the expulsion of more vitreous and should be avoided. Any iris that may also engage in the wound should be excised at the same time, without using iris forceps. No attempt should be made at fixing the globe, but the patient should be told to look up and keep as quiet as possible while the operation is being done.

In the majority of cases of vitreous prolapse this treatment generally ends in a resumption of the healing process, and in a day or so there is no evidence of the accident. The approximation of the wound edges is generally assisted by a light pressure bandage.

When the loss of vitreous is considerable the intraocular injection of sterile, warm, saline solution restores the normal tone and shape of the eyeball, and is a procedure to be warmly recommended.

It sometimes happens that the vitreous becomes incarcerated in the wound, in which case the evil results are almost as bad as those noticed in prolapse of the iris, namely, post-operative astigmatism, iritis or iridocyclitis, opacities in the pupillary area, and the formation of bands in the vitreous. As also in iris prolapse, wounds that contain vitreous remnants show evidence of this condition for an indefinite time after the healing of the scar. Indeed, an incarceration of the vitreous may lead not only to much the same post-operative conditions that one notices in iris prolapse but, in all probability, the deeper infections are more liable to happen than in uncomplicated iris prolapse. Among the complications are distortion, displacement and enlargement of the pupil, with or without hernia of the iris.

Opinions differ as to the gravity and dangers from loss of vitreous attendant upon cataract extraction. Henry Smith maintains that small losses are harmless, while other operators believe that every vitreous escape interferes with the smooth healing of the wound and invites subsequent distortion of the pupil and infection of the ocular interior. There can be no doubt but that the great majority of cases of vitreous loss during extraction of senile cataract do not materially endanger the success of the operation. On the other hand, however, many evil results flow from such an accident and the operator should ever be on the alert to prevent it.

Knapp (*System of Diseases of the Eye*, Vol. 3, p. 806) mentions several of the *simpler sequels of cataract extraction.*

Among these is *filtration chemosis.* This is not a grave condition although, like atropin irritation, it appears to be more serious than it really is. It shows itself as a unilateral edema, generally in the lower part of the ocular conjunctiva, the opposite side not being affected. This edematous condition arises from leakage from the anterior chamber (like the filtration edema seen after the Elliot trephining operation) which may be entirely restored after the extraction. Apart from this, there is no pain or other signs of irritation. The *treatment* consists in a compression bandage, and other precautions which one would take in delayed union of the operative wound.

Herpes corneæ occurs in a small number of post-extraction cases. Almost without warning one notices circum-corneal injection, lachrymation and sudden pain. On inspecting the cornea a dozen or more small, quite superficial vesicles are seen. From each one of these hangs a small strand of tissue, which fact furnishes, also, the name *filamentous keratitis* to this disease. The lesions and the accompanying symptoms disappear almost as quickly as they came; the patient is soon quite comfortable but is subject to relapses every few days for two or three weeks. However, the corneal disease does not appear to cause permanent damage to the cornea or other ocular tissues.

An examination by the microscope shows the tissue shreds that hang from the corneal vesicles to consist of chains of twisted epithelial cells. In some cases these small shreds also hang from the operative wound.

Treatment consists in the use of mild antiseptics, occasional irrigation of the conjunctival sac and, according to some authors, a pressure bandage is of use.

An alarming and rather remarkable condition is that known as *spongy gelatinous exudation into the anterior chamber.* The conjunctiva and eyelids become red and swollen, the patient complains of considerable pain, the iris becomes dull in color, contracted and immovable, and the anterior chamber is filled with a turbid exudation. The vision is much reduced. However, in spite of these threatening symptoms the condition almost invariably improves within a very short time. The anterior chamber clears up and the exudation disappears by absorption to such an extent that sight is as good as before its occurrence. Generally it disappears altogether; the iris becomes bright, the pupil black—just as before. The *treatment* of this condition is the use of atropin and simple cleansing of the eye. Knapp believes that this spongy exudate is almost certain to disappear with or without treatment, notwithstanding the alarming appearance of the eye in the first instance.

The same acute observer, speaking of the *filiform synechiæ* which not uncommonly unite the edge of the pupil to the lens capsule—especially if the iris be updrawn or if the extraction be done without iridectomy—believes that these are generally shreds of capsule attached to lacerations in the pupillary margin of the iris. He says "this is what I might call mechanical agglutination. In the extraction of the lens within the capsule it never occurs, and in peripheric incision of the capsule almost exclusively at the capsular wound. I have been able to demonstrate this in hundreds of cases; there were synechiæ only where the iris touched the capsular incision, whereas everywhere else the pupil was free; moreover, when the incision of the capsule was made sufficiently near the equator of the lens, so that the pupillary border could not get in contact with it, there was no posterior synechia. This is the chief reason that has determined me to prefer the peripheric incision to the central, especially to the promiscuous laceration of the capsule. In every case of simple extraction of a hard cataract we can notice that the lens during its exit lacerates the pupillary edge of the iris in many points, although after the expulsion and the reduction of the iris we see nothing more of it. In order to prevent synechiæ it is wise to put a drop or two of atropine into the eye the second or third day after the operation, and keep up the instillations for a week or longer."

Delayed union of the margins of the incision. One generally expects, and usually finds, union of both superficial and deep wounds in from seven to ten days after the extraction, but delay in healing is not uncommon. As a rule the interval is not greater than two weeks, but may be much longer. The explanation of this phenomenon is not the same in each instance; it is said to result from frequent reopening of a partially-healed wound; from the prolonged use of cocain; from poorly-nourished tissues; from defective reparative powers (Harlan), and from the formation of a capillary fistula. through the intervention of a few lens fibers or some of the lens capsule. In many instances there seemed no adequate explanation of the non-union.

Most observers have remarked the absence of infection in these cases that might reasonably be expected to invite such an attack; but the continual outflow of aqueous probably prevents it. However, Barck, Maynard, and others have reported cases of intraocular infection at least associated with delayed union of the wound.

When there is an obvious cause for this delay in repair of the wound it should, of course, be removed, but as a rule there is little to be done except to keep the parts clean and protect them, especially at night, by a light shield and dressing. In its own good time the wound will unite, the anterior chamber reform, the iris recede and the aqueous cease to escape.

Frank Allport employs superficial cautery of the wound edges with some mild escharotic; other surgeons use the galvanocautery, while still others advise freshening the incisional margins by means of a sharp spatula or curette.

Harold Gifford (*Ophthalmic Record,* January, 1912), mentions a very effective measure which he learned from Horner, of Zürich, as a remedy for *nonclosure of the wound* after cataract expression. The lids are left untouched by any dressing; the eye is covered with a pasteboard shield as a protection from external violence, and the wound closes promptly. He says that of 750 expressions and 50 extractions of senile cataract he has had from 25 to 50 cases in which the wound was not closed by the fourth or fifth day. These were treated by keeping a moist dressing on the good eye to keep it still, while the lids of the eye operated on were left free from pressure and protected by a pasteboard shield. In all cases the wound closed permanently in from one to three days after the cotton was left off. There has been no necessity for reopening and scraping the edges of the wound, searching for capsule fragments, sliding over a conjunctival flap, cauterization of the wound, etc.

Lakah (*La Clinique Ophtal,* Vol. XVII, June, 1911, p. 291) describes an *opacity of the cornea* which is sometimes observed after a successful cataract extraction *when the anterior chamber has not been reestablished.* This opacity is generally seen in the center of the cornea, and is caused by an anterior synechia, the lip of the iridectomy wound being the adhering point. This opacity may spread over the whole pupillary area, thus nullifying the operative result. It is probable that an alteration of the epithelial cells at this point allows the aqueous humor to enter and to opacify the cornea. Even when a tardy reestablishment of the anterior chamber has taken place this opacity will persist; there is then but one thing to do, namely, to go through the cornea with a lance-shaped knife close to the synechia, and then to break the synechia with a spatula or a fine blunt hook. One will be surprised to see these opacities immediately begin to clear up, even though they have persisted for a long time. If the condition is of recent standing the application of the actual cautery to the corneal wound and the use of atropin will often suffice. Lakah thinks the cautery restores the vitality of the cornea, the lack of which has allowed the iris to become adherent.

Expulsive hemorrhage. This is one of the most dreadful accidents that can happen to any patient, and, although it is exceedingly rare, is always feared by the operator. de Wecker has reported 8 serious hemorrhages in 3,000 operations, while Sattler saw only 4 in the same number. The bleeding may occur in any operation that involves the opening of the eyeball, iridectomy, for example, but it is in cataract operations that it is more commonly seen and dreaded. The blood invariably comes from a ruptured choroidal vein. It collects between the sclera and choroid and eventually ruptures the latter. It occurs mostly during operation but there are cases on record in which it has set in several hours or even days afterwards. The corneal flap is slowly pressed forward, vitreous presents in the wound, the zonula ruptures, the bleeding shows externally and after the expulsion of vitreous, and a blood clot, the detached retina and choroid follow. The dressings are found to be soaked with blood, the lids are generally swollen and in the corneal wound is seen a large blood clot. Of course, such an eye is irreparably lost.

T. Kambe (*Klin. Mon. f. Aug.,* 50, I, May, 1912, p. 543), reports a case which occurred in a man aged 81. After a flap section and iridectomy the tense capsule of the lens was opened with the capsule forceps. During the extraction fluid vitreous rushed out before the lens, which, however, was easily removed. A violent bleeding from the eye occurred immediately after the eye was bandaged, and recurred on the seventh day. As the eyeball commenced to shrink, enucleation was performed under local anesthesia three weeks later.

The microscopical examination of the eyeball showed hyaline degeneration of the pupillary margin, the vascular walls of the uvea partly thickened, liquid vitreous, and the retinal vessels very narrow. When such changes are present in an eye and a cataract operation is performed, it is possible that the liquefied vitreous may gush out before the lens, since the intraocular tension is much reduced and a filled intraocular artery with altered walls may burst. The source of the hemorrhage is most likely the choroid.

Kambe has collected 150 such cases from the literature. According to Sattler, these hemorrhages have been observed much more frequently since the introduction of cocain. He thinks that a marked dilatation of the vessels follows after the effect of cocain has ceased, which in predisposed eyes may lead to rupture. From a case of Becker's we learn that in expulsive hemorrhage exenteration ought not to be performed, because the torn retinal vessels close less readily than if they are crushed with the scissors during enucleation.

All sorts of causes are mentioned for this unfortunate accident. These are mainly extractions in a glaucomatous eye, hemophilia, disease of the choroidal blood vessels, etc. The exciting cause is anything that brings strain upon the eye, the sudden decrease in the normal intraocular pressure, venous hyperemia from vomiting, strain of coughing, etc.

The treatment of such a case is not of much avail. A pressure bandage may be applied, and protruding remnants of choroid, retina, vitreous, etc., snipped off. Ice has been applied and writers on the subject have suggested hypodermic injections of morphin, adrenalin, and even ergotin in the usual solutions. Some surgeons give 15 grains of calcium chloride every hour. Others advise an immediate use of a scleral-corneal suture. Finally, when no treatment avails, evisceration, packing the eyeball with gauze, or enucleation, is indicated.

Far better than the treatment of a case is prophylaxis. This consists of any measure calculated to minimize the tendency to choroidal rupture, such as a suitable diet, purgation, iodides and, perhaps, gelatine injections (q. v.). A preliminary iridectomy is indicated in suspected cases and the section should be made as slowly as possible so that the tension of the eye may not be diminished too suddenly. Of course, complete rest should be maintained after the operation.

Post-operative iritis. This process is probably always associated with irritation or inflammation of the rest of the uveal tract—especially in the severer forms. It varies greatly in intensity, from the simple form due to mechanical irritation of the iris, caused by retained lens matter, to the most pronounced cases in which direct infection is the evident source of the inflammation.

In Hudson's review (*Oph. Review,* May, 1910) of a paper by Elschnig in Graefe's *Archiv,* 26 cases of intraocular inflammation occurred in a series of 377 cases of cataract extraction. In 11 cases, which include those of the greatest severity, but in which the symptoms varied considerably in acuteness, "streptococci in the wider sense" (this term including the pneumococcus) are held with considerable probability to have been responsible for the inflammation; the evidence on the point is, however, to some extent conjectural. In the second group of 15 cases, the symptoms, which were for the most part mild in character, but occasionally severe, are attributed to manipulation and chemical irritation, *e. g.,* from lens remnants, an infection being here discounted on quite insufficient evidence. The inflammatory symptoms were frequently not noticeable for several (as many as twelve) days after the operation. Hancock in Volume XVIII, part 1, of the *Royal London Ophthalmic Hospital Reports* has described three cases of post-operative infection with prolonged latent period and peculiar course, in two of which a staphylococcus albus was proved to be the exciting cause. The reviewer has met with a case of slowly progressing iridocyclitis following cataract extraction in which a staphylococcus albus was recovered from the aqueous and in which sympathetic ophthalmitis subsequently developed, and other cases in which months or years after an extraction-operation, apparently fulfilling all surgical ideals, a plastic irido-cyclitis of extreme severity has developed in the fellow eye with complete or almost complete absence of symptoms in the operated eye. A consideration of the phenomena met with in such cases as these and of those associated with sympathetic inflammation suggests possibilities with regard both to subacute and latent post-operative infections, which are at present little or not at all understood and emphasizes the inadvisability of dogmatic conclusions on any but the most circumstantial evidence as more likely to retard than to promote progress. The question is still further complicated by our lack of knowledge as to the etiology of so-called idiopathic iridocyclitis and its relation to systemic infection or intoxication, a subject to which Elschnig refers in only the briefest terms.

The method of examination of the conjunctiva preliminary to operation, which is strongly recommended by Ulbrich, consists in the inoculation of serum-bouillon tubes with all the available conjunctival secretion, which is obtained by suction into, and subsequent expulsion from, a long capillary tube similar to that used in the estimation of opsonic indices, the mouth being used for this purpose in preference to a rubber cap. This method revealed the presence in the apparently normal conjunctiva of streptococci (including pneumococci) in no less than 30 per cent. of the Prague cataract patients.

The details given by Elschnig afford a strong argument against the practice, probably very uncommon in this country, of simultaneous bilateral cataract extraction, more especially when performed shortly after excision of the lacrimal sacs.

Herbert warns us against leaving in the anterior chamber the "milk" of Morgagnian cataract, which acts as a decided intraocular irritant. Among the other causes are (a) too long or too forcible irrigation of the anterior chamber, or lavage with any fluid but sterile, dust-free, normal salt solution at the body temperature; (b) operative traumatism, such as occurs in tearing or bruising the iris with dull instruments, in the forcible expression of the lens through a too small section, and in dragging on the membrane by the iris forceps when the patient suddenly rotates the globe; (c) injury to the eyeball during careless nursing, by a badly-fitting mask or dressing, by a finger thrust or by some injury received during sleep; (d) more rarely as a part of the recurrence of a diabetic, syphilitic or rheumatic process.

The symptoms generally set in several days after the operation—the later the milder. These are, at first, slight lachrymation, edema of the lids, pain (generally worse at night), slight photophobia and evident ciliary congestion. The pupil is, as a rule, contracted and is not readily affected by atropia; the iris undergoes color changes and there is nearly always some lymphoid exudation. These signs of the disease persist for a variable period, most cases recovering under atropia, hot applications, Credé's ointment and dionin.

When the inflammation persists a complete course of mercurials, with or without sweats, is indicated. The efficacy in some cases of subconjunctival injections (q. v.) should not be forgotten. I have much faith in salicylates when given as Gifford prescribes. (See **Iritis.**)

Even when the pupil eventually becomes occluded some form of secondary operation may restore much of the lost vision. These interventions are not to be allowed, of course, until the eye has become entirely quiet, and their success is more than doubtful should the globe have meantime become soft or if it remains for any great length of time tender to the touch. In such cases one may suspect a deeper involvement of the uveal tract.

Post-operative iridocyclitis. This formidable disease may generally be regarded as a more pronounced form of infection than that described above and is, as a rule, followed by complete loss of useful vision. Cases present, within 24 hours after the extraction, the symptoms of acute iritis, followed soon by marked evidence of an intraocular inflammation, i. e., a blurred, swollen iris with exudates at its margins.

In spite of all treatment (which is substantially that suggested in the severer form of iritis) the pupil generally fills with fibrinous masses, there is an updrawn pupil and, finally, an iris bombé. Now and then, however, the eye becomes quiet and some form of iridotomy (q. v.) may eventually be instrumental in restoring a fair amount of sight.

Infection of the operative wound. In spite of our boasted improvement of asepsis and antisepsis, infections remain the most serious complications of cataract extraction. Although, as in advanced anemia. arterio-sclerosis, lachrymal disease, etc., one is obliged to run certain unavoidable risks, yet definite microbic invasions of the operative wound are, after all, the *bête noire* of the surgeon. The time and the occasion may vary from the moment of the puncture that opens the anterior chamber to weeks or months after the operative wound has healed, but the admission of bacteria or toxins, or both, to the interior of the eye will generally account for the majority of post-operative disasters. It is not intended to deny the verity of endogenous infection or to minimize the lowered resistance of the tissues that is not infrequently encountered in old people with nephritic and other organic changes, but these facts should not be allowed to cloak a more important factor—septic infection.

The most common predisposing cause of bacterial invasion is prolapse of the iris, prolapse of the vitreous and the incarceration of portions (however minute) of these and other tissues between the lips of the wound. Such accidents, as well as an irregular corneal cut, prevent that clean, smooth and early adhesion of the incisional margins that is the best guaranty of a successful operation.

It is always safe, where the iris is not perfectly active and clear on the day following the operation, to instil four or five times during the 24 hours two drops of a 1 per cent. solution of atropine. At the same time a purgative should be given, and an effort at once made to discover the cause of the iritis. Once this is done it is often possible to prevent further progress of the disease. Should the inflammatory conditions continue for a few days all bandages should be removed from the eye and a 5 per cent. solution of dionin combined with the local atropine treatment. There is much in favor of the Gifford method of using salicylates, it matters not what the underlying cause of the iritis may be.

Some surgeons find considerable value in sub-conjunctival injections of a 1 per cent. salt solution. The cyanide and other salts of mercury give much better results when combined with one per cent. acoin (q. v.) and the injection is robbed of much of its painful consequences. I have used 1 to 4,000 to 1 to 2,000 solutions, repeated every two or three days, with considerable success. I prefer the mercuric oxycyanate to the cyanide salt.

In conjunction with these local and general measures, the conjunctival sac may well be irrigated with 1 to 10,000 bichloride two or three times a day, followed by the use of White's ointment. Hot fomentations and Leiter's coil will generally relieve pain. At this stage of the inflammation, and when cyclitis is suspected, the writer generally applies Credé's ointment to the lids at night-time. Reference has already been made to the applications of the electro-cautery to the wound margins in evident infection of the incision.

Suppuration of the extraction wound. This is by far the most serious late post-operative calamity that can involve the eye operated on, as it almost always terminates in panophthalmitis and complete loss of sight. Following the rule of post-operative infections the involvement of the eye shows itself within a few hours after the patient is put to bed and the signs of the accident are quite marked. The pain in and about the eye is severe, the swelling of the upper lid is pronounced, the globe is very tender, the secretions are copious and the cornea is decidedly steamy. The wound margins sooner or later become swollen, whitish-yellow and exude a purulent discharge. Hypopyon is seen and the anterior chamber soon fills with the exudate. In spite of all treatment the invasion of the cornea and iris continues and most of the former melts away as a part of the destructive process. Finally the vitreous is infected, the wound opens widely, and the picture of a panophthalmitis is complete.

The treatment of this condition is of little avail but in addition to the applications just mentioned subconjunctival injections of the cyanate of mercury and the introduction of iodoform coloids or Haab's discs may be tried in conjunction with deep electro-cauterization of the wound. Kuhnt's plan of scraping the infected wound margins and then covering them with conjunctiva may also be worth a trial.

The propriety of enucleation (or some substitute for it) in the presence of an eye destroyed by this deep infection is fully considered under **Enucleation.** In my opinion it should not in the interests of the fellow eye be long delayed.

Post-operative or late complications of senile cataract extraction. This section should be read in conjunction with Ellett's on the **After-treatment of ophthalmic operations** in general. I have supplemented his remarks by discussing the chief processes and diseases one may encounter any time after the patient has passed through the first operative ordeal.

Doubtless there are extractions in which no forethought and no surgical skill can prevent an untoward result yet it must be admitted that lack of experience on the part of the operator, inadequate ante- or post-operative measures (including insufficient aseptic precautions) and defective technique, one or all pretty well explain the great majority of failures to improve the vision of a cataractous eye. Indeed, a consideration of the means by which unfortunate terminations of this important operation may be avoided leads us inevitably to the principles repeatedly stated, viz: a proper technique faithfully carried out in an eye fit for operation. It is not enough to have the instruments, hands and operative field aseptic and kept aseptic until the healing of the operative wound; the extraction itself should follow the lines proved to be correct by experienced operators.

Post-operative opacities of the cornea. Under the titles striped keratitis, filamentous keratitis and post-operative keratitis, various forms of streaky cornea are described. I have seen it a number of times after irrigation of the anterior chamber and have believed it to be due to injury of the endothelium from improper lavage. It cannot be too often repeated that although a most valuable assistant in freeing the ocular interior of irritant particles, care should be taken to do the irrigating gently and with dust- and germ-proof fluids indifferent to the eye and of a temperature kept as near 100° F. as possible.

Other forms of corneal traumatism are also said to be responsible for these linear opacities of the cornea, such as tight bandages, the too free use of instruments and the squeezing of a large lens through a narrow section. The hazy lines sometimes assume the form of patches or well-defined nebular areas.

There is no special treatment for any of these conditions; they usually disappear in a week or two, although the writer has seen two cases with nebulæ in which the cloudiness persisted and greatly reduced the vision.

Incarceration of the iris in the wound of operation. Prolapse or hernia of some part of the iridic tissues is more common in the simple than in the combined operation but in either procedure may be followed by inhealing or incarceration of the iris as a serious after-complication. When prolapse occurs it almost invariably shows itself during the first day after the extraction. This fact justifies, as before said, the critical but careful examination of the eyeball twenty-four hours after the completion of the operation. Better results probably flow from the immediate treatment of early prolapse than to leave it for future consideration.

The extent of the prolapse, as well as the degree of incarceration of the iris, varies from a mere linear adhesion to some part of the wound edges, to the extrusion of one or more knuckles or folds of iris.

The causes of prolapse are chiefly injury to the parts or any violence that may reopen the wound. Sneezing, coughing, straining at stool and vomiting are among these, as well as accidental blows on the dressings, finger thrusts, squeezing of the lids, sudden movement in or out of bed, undue pressure of the bandage mask or shield, etc. Sometimes the normal intraocular pressure exerted by the mass of the vitreous on the iris appears to explain some forms of prolapse.

Extreme care should be exercised in removal of the dressings at the first few inspections of the eye following an extraction, because, as Swanzy and others have shown, the iris may be washed or pushed into the wound by the sudden outflow of aqueous induced by the opening of the lids and the consequent disturbance of the wound edges. This fact brings home to one the reasons for the numerous operations devised by operators to provide such a sluice-way (iritomy, iridotomy) for the escape of aqueous as will permit effective drainage without carrying the soft tissues with it. It explains the more frequent occurrence of prolapse in the simple operation, as well as the value of the conjunctival flap in all operations.

Among the predisposing causes, apart from an intact iris, are paresis of the iridic muscular fibres due to injury or to the force employed in expelling the lens, a needlessly wide iridectomy, and the presence of cortical remains in the anterior chamber.

If we are to draw any conclusions from the statistics of operators iridic prolapse must be an exceedingly variable incident. Marshall's figures (in 1,091 cases) give 13.87 per cent. in the simple operations as performed at Moorfields, and 0.87 per cent. for the combined procedure. Galezowski reports prolapse in one-half of one per cent. in 200 simple extractions; Herbert, 8.37 per cent. in 490 simple cases; Swanzy 1.13 per cent. in 354 operations with iridectomy.

Sequelæ of iris prolapse and incarceration. That part of the prolapsed iris, whether it be large or small, that shows outside the eye is soon covered with lymph and adheres to the surrounding tissues. If not replaced or excised the iridic pigment before long begins to undergo absorption so that the whole membrane is really thinner than normal, while through all—exudate, iris and such proliferating epithelium as grows from conjunctiva or cornea—the aqueous slowly filters. Indeed, a filtration area is here established which often lowers the intraocular tension and may act as a safeguard against glaucoma, as that disease is often seen in iridic hernia.

A distorted and displaced pupil is a common sequel of an incarcerated iris. Not only is the pupil often drawn quite up to the half-formed scar (cystoid cicatrix) but its area is likely to be more or less occluded from iritic deposits. Such a condition is a continual invitation to toxic and bacterial invasion of the intraocular tissues, and years after the operation uveitis and sympathetic ophthalmia may result from infection of the interior of the globe.

Although a conjunctival covering is a hindrance to and may entirely prevent these evil consequences of prolapse and hernia of the iris yet it must not be forgotten that even after superficial healing has taken place the deep wound may be prevented from uniting and so admit a part of the iris between its lips. In such cases there is probably a foreign body (capsular fibril or cortical remnant) wedged in between the lips of the deep incision.

If the hernia of the iris be wide a considerable amount of astigmatism is the result, and as this anomaly is likely to be of the irregular variety a serious interference with vision is certain to follow.

To add to the discomforts of the patient the uneven surface of the globe prevents the lid edges from performing their proper cleansing function; mucus, harboring bacteria and fouled with toxins, is insufficiently wiped off the eyeball and both conjunctival and ciliary irritation is a common consequence.

The treatment of iris prolapse should precede that for secondary cataract, to avoid, as much as possible, loss of vitreous. If the prolapse be observed within the first twenty-four hours (when the great majority of them happen) the eye should be cocainized, thoroughly disinfected and an attempt made to replace the errant tissue with the stream from an irrigator or by means of a spatula. This reposition should be followed by the use of eserin and the question may well arise as to the advisability in the particular case of resorting to the conjunctival flap of Kuhnt.

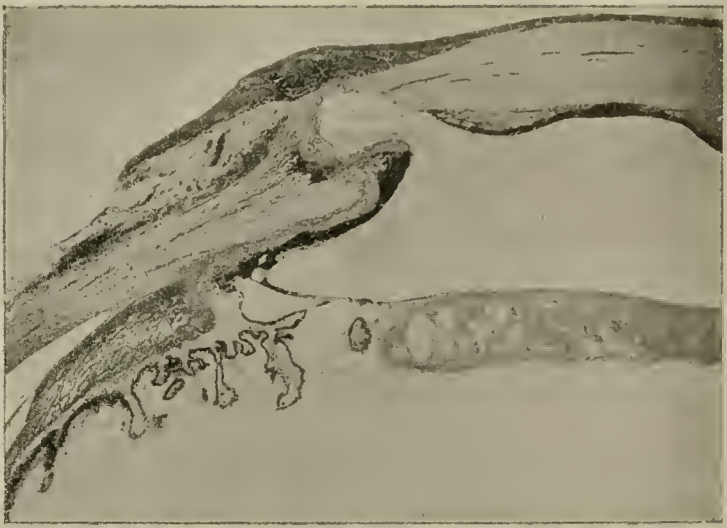
After the prolapse has assumed the condition of an actual incarceration, or has been exposed to external infection for several days, excision is the proper proceeding. The longer the interval between the prolapse and the operation the greater the difficulties to overcome. The wound is irritable, the eyeball tender and the iris congested; cocain has little effect and neither fixation forceps nor speculum can be used for fear of vitreous loss. The eyeball and sac should be thoroughly irrigated with hot normal salt or boric solution, followed by the use of cocain and adrenalin. Herbert suggests the application of a few crystals of cocain to the wound. The lids are now firmly separated by an assistant (or a retractor is used) and the extruded fold of iris firmly seized and drawn out by a pair of fine iris forceps. This act is always painful and the excision of the iris with the scissors (well pressed against the globe) should follow almost simultaneously. Otherwise the patient suddenly and forcibly rotates his eyes upwards, the opportunity to excise the part is lost and the end of the iris forceps is in danger of bruising the wound edges or even of being forced into the anterior chamber.

Should the conjunctival flap cover the prolapse the former may be turned back with forceps and the operation carried out as just indicated.

After an early performance of this operation the edges of the iris wound may fall well into the anterior chamber and form the ordinary coloboma of an iridectomy, but in any event the excision generally exercises a good influence on the incarceration as a whole; the mass of tissue about the wound generally contracts and a flat scar is the final result; which is better than if, as some surgeons suggest, the incarcerated tissues be left undisturbed. However, the dangers of late infection are still by no means unreal, while the cosmetic and visual results are not flattering. Here, even more than in early prolapse, are the protective conjunctival flaps of Kuhnt and others to be recommended.

On rare occasions it is possible to sever (as in the operation for anterior synechiæ) the connection between the intraocular portions of the prolapse and the deep wound by Lang's twin knives. When this is accomplished the extraocular tissues may be excised or even seared with the galvano-cautery.

Prevention of iris prolapse. The literature of this subject is so extensive that it is impossible to refer even to the most important part of it here, especially as the essentials have already been discussed.



Cystoid Cicatrix and Secondary Cataract After Extraction.
The Anterior Chamber is Relined with Epithelium. (Elschnig.)

There are, however, a number of procedures intended to prevent prolapse of the iris that should be considered.

Bell Taylor *(The Lancet,* Vol. 2, 1871, p. 802), extracted cataracts through an opening in the base of the iris (so made as to leave the pupil quite untouched) to guard against prolapse and hernia of that organ. He made a small but peripheral iridectomy which was enlarged by a cut with fine scissors on each side. The objection to this method is its complicated technique, the difficulty in expelling the lens through a small opening and the subsequent distortion of the pupil.

Schweigger did a basal iridectomy in conjunction with a downward corneal section for the purpose of preventing iridic prolapse. As elsewhere stated, these openings in the iris generally close completely and, no doubt, assist in preventing a subsequent hernia of the iris.

After, or secondary, cataract. Following the great majority of simple and combined cataract extractions some opaque matter—generally membranous—can be found in the anterior chamber. A description, as well as the conduct of these cases, is well set forth under **After-**

cataract and to such I would refer the reader for a consideration of, perhaps, the most important complication of senile cataract extraction. See, also, **Cataract, Secondary**.

Glaucoma following the extraction of senile cataract. Although the occurrence of any form of post-operative glaucoma is so rare (two to three per cent.) as to give rise to a suspicion that we mostly have to deal with the revival of an old process, or with a pure coincidence, there is no doubt but that the altered conditions introduced by the operation are sometimes responsible for the increased tension and other symptoms. Moreover, the fact that it shows itself more frequently in the combined than in the simple operation argues in favor of a true operative glaucoma. The iritis, uveitis, posterior synechiæ, occluded pupil, etc., known to produce glaucoma apart from operation may also set it up in association with an extraction. Added to these causes are others that block the canal of Schlemm or the sclero-iridian angle. Among them are displacement of the margins of the coloboma forward, pressing the root of the iris against the angle, proliferation into the anterior chamber of the corneal and conjunctival epithelium, tags of tissue caught in the incision and dragging on the iris and ciliary body, as Parsons claims, and direct stoppage of the filtration current by cortical and other débris.

The treatment of a disease due to so many different causes must, of course, be regulated by a strict inquiry into its origin in each case. The increased tension in glaucoma generally subsides for a time after a paracentesis; if the conditions are favorable an iridectomy may be done forthwith. Inflammatory conditions are better treated by dionin and atropia than by eserin. Division of membranes that occlude the pupil or drag on any part of the uvea is indicated. The formation of a filtration cicatrix after the plan of Lagrange or Elliott is to be advised in glaucoma following the combined operation. When judiciously applied the treatment of this complication is as successful as in glaucoma not associated with cataract extraction.

Choroidal detachment. Detachment of the choroid as a complication of cataract extraction was first reported by Knapp (1868.) Recently it has been studied by Fuchs who attributes the accident to the passage of aqueous through minute tears at the filtration angle into the suprachoroidal space. Thomson Henderson believes it to be essentially a passive serous collection in this locality due to low ocular tension the result of a leaking wound in the eyeball.

It is difficult to say whether this condition is of rare or frequent occurrence as it interferes little with vision, is rarely permanent and disappears when the incisional wound heals and the eye regains its normal tension. Separation of the choroid varies much in extent and duration. It generally affects the lateral quadrants of the eye and does not extend beyond the exits of the venæ vorticosæ. As it occurs during a time when one does not usually care to disturb the eye by a rigid ophthalmoscopic examination, and as the detached portion is of the same color as the rest of the fundus, it is not easy to make out its dark, curved, posterior boundary, while even the displaced retinal vessels may escape notice. The treatment of this peculiar condition is bound up with that of the minus tension that gives rise to it.

Detachment of the retina after cataract extraction. The conditions under which the operation is responsible for retinal detachment have not been clearly defined by writers on the subject except to say that it may be expected and is mostly caused by large loss of vitreous. It seems rational to expect it in those cases, of which Treacher Collins has described several, where there is adhesion—direct or indirect—between the hyaloid and the wound of incision. In highly myopic eyes one may look for it, especially after rupture of the posterior capsule, loss of vitreous or after sudden expulsion of the cataract. It is also a genuine result of advanced iridocyclitis due to faulty extraction and infection. Yet retinal separation is a comparatively rare complication of extraction and its prophylaxis and treatment do not differ from cases encountered in other connections.

Endogenous infection. Although its existence has been denied and doubted for many years yet the accumulated evidence does not permit us to ignore possible endogenous infection of an eye previously operated on for cataract. In other words, not all post-operative changes are the result of local infections or traumas. Systemic, including bacteriological, examinations have demonstrated that many extra-ocular diseases may communicate their *materies morbi* to an eye recently operated on. In Europe Selenkowsky (*Archiv. f. Augenheilk.*, 47, 1903, p. 299), Wolfner (*Klin. Monatsbl. f. Augenheilk.*, 1906, p. 386), Dor (*Bull, et Mém. de la Soc. franç d'Ophtal.*, 1901, p. 292), and many others, as well as White (*Jour. Am. Med. Assocn.*, June, 1904), de Schweinitz (*Ophthalmic Record*, Dec., 1905, p. 580) and others in America have shown that, among many more, serious metastatic processes in the ocular structures may be set up by erysipelas, gonorrhea. pneumonia, suppurative bronchitis, otitis, pleurisy, meningitis, malaria, typhoid fever, pyorrhea dentalis, syphilis, tuberculosis, etc., and that even unsuspected bodily foci may infect the eye recently operated on, especially its uveal tract. The experiences and experiments of Selenkowsky shows that under certain conditions bacilli circulating in the blood may penetrate (by way of the posterior ocular vessels) the eye and reach the vitreous chamber. Sometimes the inflammation thus produced is of the quiet sort; very often, however, it takes the form of an acute intraocular infection.

The *treatment* of these cases, apart from that of the general condition, is the same as that indicated in local infections, especially infections of mercuric cyanide. It is well to remember in this connection that as a precautionary measure Louis Dor has recommended preparing patients for cataract extraction by giving them the evening before and on the day of operation two grams of potassium iodide.

Obarrio has noticed a *reflex hyperemia of the conjunctiva* as a postoperative phenomena which he believes to be due to decayed teeth acting through the ganglion of Gasser and the trigeminus. The treatment (both precautionary and curative) is to remove the cause.

Sympathetic ophthalmia, as a late development of cataract operations, is not unknown. Marshall asserts that it occurs in 0.61 per cent. and Vossius in 0.19 per cent. of all cases.

Visual results after senile cataract extraction. It cannot, of course, be expected that the (elderly or aged) patient will have any better sight after the removal of the lenticular obstruction to vision than he would have had at the same period of life in the absence of cataract, and yet normal vision is not uncommon after cataract extraction. The patient often recovers excellent distant sight, reads the finest print, becomes reconciled to the loss of his accommodative range and seems to have taken a new lease of life. It must be remembered, however, that secondary changes in the posterior capsule may, later, lower the visual acuity and that other causes may breed dissatisfaction with the primary result, but as a rule the extraction of the senile cataract, carried out with a rational conception of its responsibilities, is a procedure preëminently satisfactory to both patient and surgeon.

Since statistical results—and their number is legion—are very misleading, if for no other reason than that they depend upon extreme variableness in the factors that compose them, I am not inclined to quote them to any extent, except to say that one might count himself a good surgeon with three per cent. of eyes lost (or vision nil) generally from irremediable iridocyclitis, glaucoma, panophthalmitis, expulsive or severe intraocular hemorrhage, vitreous opacities and detached retina.

Poor results (in which the best vision obtainable is less than 6/60 or 20/200) should not exceed seven per cent., mostly due to closed pupil, uveitis of varying degrees, iritis with anterior or posterior synechiæ, glaucoma, squint, loss of vitreous, vitreous hemorrhage, corneal opacity, retinal detachment, thick membranes in the pupillary area and iridic prolapse.

Seventy per cent. of the cases operated on should have good vision, with the ability to read ordinary print and to follow the occupations proper to the age and station in life of the patients.

Between what I have called "good" vision and "poor" vision lies an uncertain and debatable category of twenty per cent. a part of which would be regarded by the optimist as examples of satisfactory vision or good sight; by the pessimists as poor vision and a failure of operation.

I have on several occasions expressed some skepticism regarding the value of *statistical tables* of cataract extraction, and have given my reasons for deprecating the importance commonly attached to them. For example, in the following tables only *mature* senile cataract was operated on, so that it is no wonder that one result of the work is only 1.6 of secondary cataract. However, as statistics have their place in a work like this, one of the most important tabulations, that of Rollet (*Revue Gén. d'Ophtal.*, Aug., 1910; abstract, *Oph.-Review*, p. 123, 1911), is given.

Of the 1673 senile cases (of all varieties there were 2430 extractions) no iridectomy was done in 929 instances.

The mean *age* was 64 years; 93.1 per cent. were aged from 41 to 96, 4.1 per cent. aged 30 to 40; younger 2.6 per cent. *Consistence* was half-soft in 52.7 per cent., soft in 4.2 per cent., hard in 31.8 per cent., regressive in 4.8 per cent., Morgagnian 3.4 per cent.

Senile in 86.6 per cent., familial 0.3 per cent., diabetic 1.1 per cent., albuminuric 0.3 per cent., secondary 0.6 per cent., adherent 2.5 per cent., traumatic 3.6 per cent., dystrophic 1.9 per cent., with luxation 0.5 per cent.

In his first 500 senile cases sphero-cylinders were ordered after five or six weeks, but in his later 1673 cases spheres were given about ten days after operation. He gives interesting records of 298 cases examined at remote periods (3 months to 9 years after operation) and of 1673 cases with early immediate results:

Vision.		1673 "early" cases.	298 "remote" cases.
	1	0.1 per cent.	2.6 per cent.
$\frac{2}{3}$	$\frac{1}{4}$	5.4	40.6
$\frac{1}{5}$	$\frac{1}{8}$	19.6	27.8
$\frac{1}{9}$	$\frac{1}{10}$	16.3	7.7
$\frac{1}{11}$	$\frac{1}{15}$	20.0	5.0
$\frac{1}{16}$	$\frac{1}{30}$	20.6	9:0
$\frac{1}{40}$	$\frac{1}{50}$	6.7	3.3

Thus *visual acuities* of 1 to ¼ are obtained in 5.5 per cent. of cases where vision was tested 10 days to 3 months after operation, and in 43.2 per cent. of cases tested from 3 months to 9 years after operation. Post-operative astigmatism of 7D usually dropped to one of 2D later.

He had seen only 1.6 per cent. of secondary cataract, because he operated *only on ripe cataracts* and he paid special attention to the complete expulsion of the lens masses and practised a rigid antisepsis throughout.

A review of the *results of cataract extraction* in the principal European and East Indian hospitals is given in the *Encyclopédie française d'ophtalmologie,* VII, p. 267. From it the following figures are quoted.

In medieval times and in countries where couching or reclination of cataract is still practised (see Vol. 11, page 1473 of this *Encyclopedia*) the percentage of lost eyes was and is very large. Elliot and Maynard report the loss of vision following the operation in India as very large; only about 25 per cent. retaining the sight at first obtained for more than five years.

Coming to more recent but pre-aseptic times Gayet in 1875 said that his predecessor—Desgranges—felt satisfied if he succeeded in obtaining 75 per cent. of successes, figures which he himself reached from 1864 to 1867 by the same method, the old Daviel incision. After the adoption of the linear extraction of von Graefe, Gayet finally attained (even in 1872) 92 per cent. of good results. de Weeker and Landolt, in their text-book, report the percentage result of other ophthalmologists about this time:

	Result good.	Poor result.	Eyeball preserved.	Enucleation.
Snellen	92.30	15.60	12.30	2.50
Knapp	89.00	19.70	7.80	2.40
Arlt	83.70	16.30	.....	....
Horner	97.30	2.70	.....	....

Later, deWecker reported that of 2200 extractions in France, with iridectomy, there were 95.9 percentage of success; 3.4 per cent. unsuccessful (but with "hope of improvement") and 0.77 complete and permanent loss of sight. Without iridectomy the report was not quite so favorable—93.18 per cent. of success; 6 per cent. failures, but with a chance of improvement; while in 0.82 per cent. the visual loss was complete and irrevocable.

Further figures are given by Köllner of von Michel's clinic (Berlin) affecting 1284 extractions, all with iridectomy. There were "satisfactory" results in 92.6 per cent. of cases; iritis and cyclitis in 4.2 per cent.; secondary cataract 6 per cent.; infection of the operative wound in 0.5 per cent.

Knapp has given us the results of 1000 (New York) extractions, as follows: Successful, 96.33 per cent.; poor vision, 2.66 per cent.; loss of the eye, 1.01 per cent. In India, Maynard reports on 1000 extractions in which he had a good result (vision $\frac{6}{36}$ to $\frac{6}{6}$) in 89 per cent.; poor vision in 5.7 per cent., and loss of the eye 4.5 per cent.

The causes of *failure after extraction* are variously reported. An average example is that of Dimmer (Graz, 1905) who, following 500 extractions, has four per cent. of permanent loss of sight. This was due to infection of the wound 0.4 per cent.; iridocyclitis 1.4 per cent.; hyphema or secondary cataract 0.8 per cent.; choroidal hemorrhage 0.2 per cent.; secondary cataract nystagmus, 0.2 per cent.; glaucoma 0.2 per cent., and opacities of the vitreous 0.8 per cent.

Greeff furnishes statistics of Schweigger's clinic. Since 1888 Schweigger returned to simple extraction. The figures represent 821 operations:

	371 extractions with iridectomy.	450 without iridectomy.
Success	75.1	76.5
Secondary cataract	19.2	19.1
Loss of the eye	5.7	4.4

Post-operative astigmatism. This anomaly, according to Treutler, (Ueber die Krümmungsänderungen der Hornhaut nach Star-operationen, *Zeitschr, für Augenheilk,* June, 1900, p. 484) is due both to vertical flattening of the cornea and to increase in the horizontal curve. In some cases the astigmatism, found a fortnight after the operation, persists or is even increased later. In other cases it diminishes somewhat or may entirely disappear in the course of a few months. This reduction may be ascribed to a readjustment of the wound surfaces which had been displaced by over-riding of the corneal flap. In sclero-corneal sections it may be that the down-growth of epithelium interposes a wedge between the wound edges and keeps them apart. For this reason the abnormal curvature is generally greater in sclero-corneal sections than in those that are made entirely within the clear cornea.

Jackson *(The Ophthalmic Review,* Vol. 12, 1893, p. 349) found that in 15 per cent. of cases a permanent degree of astigmatism was reached within two months after the operation; in 20 per cent. regressive changes continued after more than three months.

Rollet (Résultats éloignés de l'opération de la cataracte sénile, *Revue gén. d'Ophtalm.*, June, 1904, p. 241) found that in examining 150 cases, five months after the operation, 25 per cent. exhibited no marked astigmatism, while the remainder had an average amount of 2.57 D. A year or more after the extraction there was either complete disappearance of the astigmatism or a small amount (at right angles to the original) had developed.

C. A. Hegner (*Klin. Monatsbl. f. Augenheilk.*, March, 1912) suggests, to relieve the *diplopia resulting from the use of a high plus lens in the aphakic eye* after cataract extraction when the fellow eye is emmetropic, the use of a spectacle shaped somewhat like a short telescope before each eye, in which several lenses of different density and curvature are used before the defective eye, and plane lenses before the emmetropic eye, the glasses being mounted in an aluminum tube, 1.5 cm. broad. Lateral vision is greatly curtailed by this method, but the restoration of binocular vision repays for this discomfort. This method is also applicable to cases of anisometropia and high myopia.

Colored vision after senile cataract extraction. Although erythropsia is an occasional complaint, especially after the patient has first been exposed to bright light, most of the other forms of anomalous color sight are rare. It has been especially noticed after a broad iridectomy and is supposed to be caused by the ultra-violet rays which are, in normal eyes, largely shut off by the lens.

Cyanopsia is a form of color vision noticed after cataract operations but it is generally transient in character. Probably it occurs even more frequently than erythropsia but as it generally lasts but a short time is not noticed by the patient. As a rule, all forms of color vision disappear within the first month after the extraction. See, also, **Blue vision.**

Flatulence and other forms of indigestion. In my experience this is the most constant and most annoying of the less formidable systemic after-effects of the operation. In consequence of the accompanying insomnia, nervousness, pains in the back and general malaise it has its serious aspects, and may indirectly contribute to a poor result or even to decided loss of vision. It can generally be avoided by taking the precautions noted under the immediate after-treatment of normal cataract extractions in this section. The lumbar pains are mostly from tired and stiff muscles, the result of cramp and fatigue, due to fear felt by the patient of turning in bed lest he injure his eye.

Mental disturbances following senile cataract extraction. The possibility of delirium, hallucinations, mania and allied symptoms after a cataract operation has already been spoken of. The mental balance of old people is especially prone to be disturbed by putting them in a dark room of a strange hospital, to say nothing of the anxiety connected with a serious operation.

The possibility of delirium tremens, insanity, atropine poisoning, meningitis, coma, cerebral hemorrhage, pneumonia, uremia, delirium tremens, and even of sudden death in these senile subjects should not be forgotten.

The majority of mentally disturbed patients recover under sedatives and judicious moral suasion. In every case the condition of the bladder, bowels, urine, blood, etc., should receive attention. Care should be exercised to prevent a temporarily insane patient from tearing off the bandages and otherwise injuring his wounded eye.

Cataract, Siliculose. See **Cataract, Aridosiliquose,** and **Cataract, Siliquose.**

Cataract, Siliquose. This is another name for a chalky-white, *generally congenital* form of early cataract that is sometimes called *membranous* cataract. As Beard (*Semiology and Diagnosis,* p. 182) points out, Louis Dor, Sr., definitely distinguishes between them as follows: One form "in which, as a consequence of anomalies of the vascular capsule, the lens was not normally formed; and another, in which the lens, though normally formed, is absorbed as a result of morbid vascular conditions. Hence, the term 'membranous' cataract is not exactly synonymous with regressive cataract, because only part of the membranous cataracts are attributable to regression. This part includes merely those forms in which, the lens having swollen to the point of bursting, the nucleus is absorbed and there exists at birth the siliquose variety instead of a soft cataract. There is thus a relation between the total soft and the siliquose. In this connection *siliquose* and *membranous* are more nearly synonymous, yet there is a shade of difference. In botany a silique (or silicle) is a fattish, oval pod, between the two valves of which are the seeds. A siliquose cataract is composed of the two leaves of capsule (anterior and posterior) enclosing certain remains of the crystalline; while, in the membranous cataract, the two leaves are in contact throughout."

Cataract, Soft. See **Cataract, Juvenile.**

Cataract, Solar. INSOLATION CATARACT. CATARACT FROM TROPICAL LIGHT. CATARACT FROM EXCESSIVE HEAT. Glass-blower's cataract, bottle-maker's cataract, and even electric cataract are thought to be due to the evil effects of intense artificial light (and perhaps heat) on the lens system. This subject is discussed to some extent under **Bottle-finisher's cataract,** page 1466, Vol. II, of this *Encyclopedia.* It may be added here that Robinson (*British Med. Journ.*, 1903) believes the crystalline itself, acting like any other strong convex lens, concentrates the rays of any intense light to which it may be exposed, at the nodal point, and thus brings about the acquired form of *posterior polar cataract* characteristic of all forms of cataract due to excessive illumination.

If this be true may not the large percentage—certainly a large number—of cataracts found in India and some other tropical and semi-tropical climates be due to insolation, i. e., to the fierce rays of the sun? The question is by no means settled; indeed, Ruata (*Annali di Ottal.* XX, III, p. 445), while admitting the excessive percentage of cataract in India, finds it rare in Martinique and Egypt. In Norway, where winter dazzling is excessive, cataract is also uncommon.

Changes in the Lens Produced by Intense (Violet-rayed) Light. (Widmark.)

However it may be with dwellers in hot countries, Dor believes that the explanation of the formation of cataract in workmen exposed to intense heat and light is easy and rational, viz.: the hydration of the intraocular albumins under the influence of the water of the aqueous humor and the long continued excess of light and heat.

Although the expression *electric cataract* (q. v.) generally refers to the lenticular changes induced by *intensity* of light and in particular by its *ultra-violet rays* yet the term "cataract from intense light" is preferable because more definite.

Again referring to Widmark's experiments in which rabbits were exposed to (a) all the rays and (b) all except the violet rays of a 4,000 candle power electric light (the eyes being protected by a filter of quinine solution and most of the violet light thus prevented from reaching the retinæ) the alterations depicted here are described in Vol. II, p. 1489, of this *Encyclopedia.*

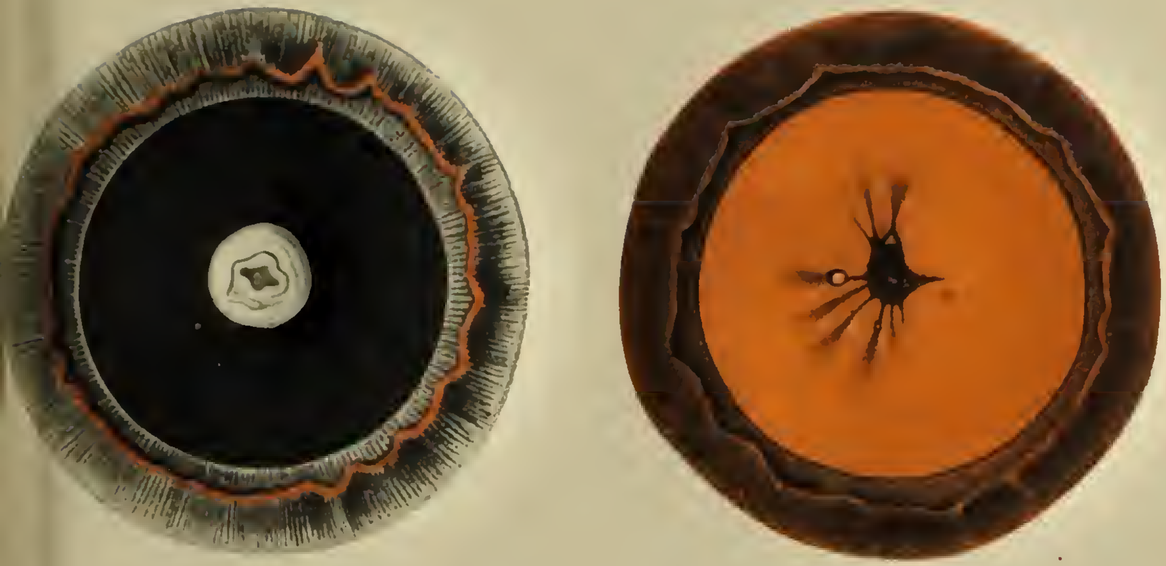
Cataract, Spindle. A synonym of *fusiform* or *axial cataract.* It is a very rare form of the disease, is generally congenital, or shows itself early in life, is often hereditary and resembles the lamellar variety. Knies first proposed the appelation ''spindle,'' which seems very appropriate. When of the transmitted type it frequently affects successive siblings; more often the first born. Nettleship gives one extraordinary pedigree of five generations containing more than ninety individuals, thirty of whom are known to have had cataract.

The connection between persistent hyaloid artery and axial cataract was first pointed out by Bach in 1897. It is to this observer that we are chiefly indebted for our knowledge of this extremely unusual lenticular opacity. He regards fusiform cataract as the result of two different (but combined) pathological processes, one affecting both lens poles, and the other the nuclear fibres.

Cataract, Spontaneous. A well-nigh obsolete term applied to lens opacities, the etiology of which cannot be explained by any of the known causes of the disease.

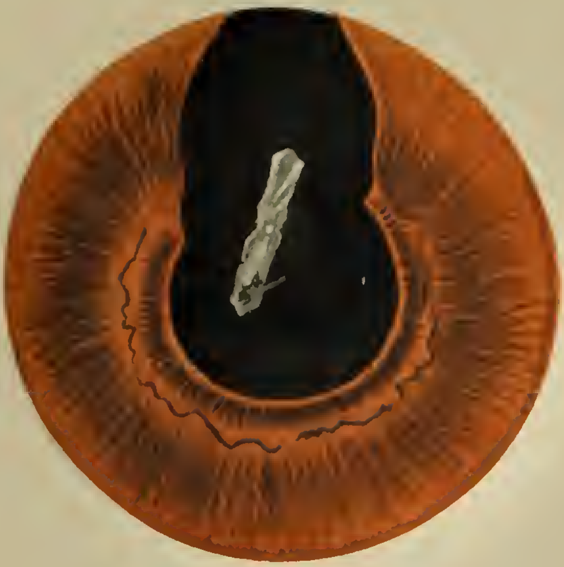
Cataract, Spurious. This form of opacity of the ocular media, constituting one form of *false* cataract, has nothing to do with the lens or its capsules. It is in most instances a deposit on the surface of the anterior capsule without implication of that membrane, and is the result of an iritis, a ''descemetitis,'' or it may even be a keratitis. Mackenzie adopted the term ''fibrinous cataract,'' and distinguished three forms of it, (1) *reticulated fibrinous cataract,* (2) *coagulated fibrinous cataract,* and (3) *trabecular fibrinous cataract.* Spurious cataract may, of course, accompany true opacities of some parts of the lens-system, and one may follow the other, as, for instance, in adherent cataract (see **Cataracta accreta**) in which the equator of the lens is first affected by the uveitis that produces opacities of its peripheral fibres. See, also, **Cataract, Uveitic; Cataract, False,** and **Cataract, Trabecular.**

Cataract, Stationary. As Wintersteiner points out (*Die partiellen, stationären Staare,* 1897, p. 3), the lenticular anomaly that appears as a typical *partial* cataract almost invariably belongs also to the *stationary class,* i. e., it retains its incomplete character throughout the whole or most of the life of the patient. Although this author fails to include certain varieties or sub-varieties of cataract in any of the classes he describes—notably the peripheral, nasal opacity in senile cataract, known as Thompsonian cataract—yet the rule just formulated holds true.



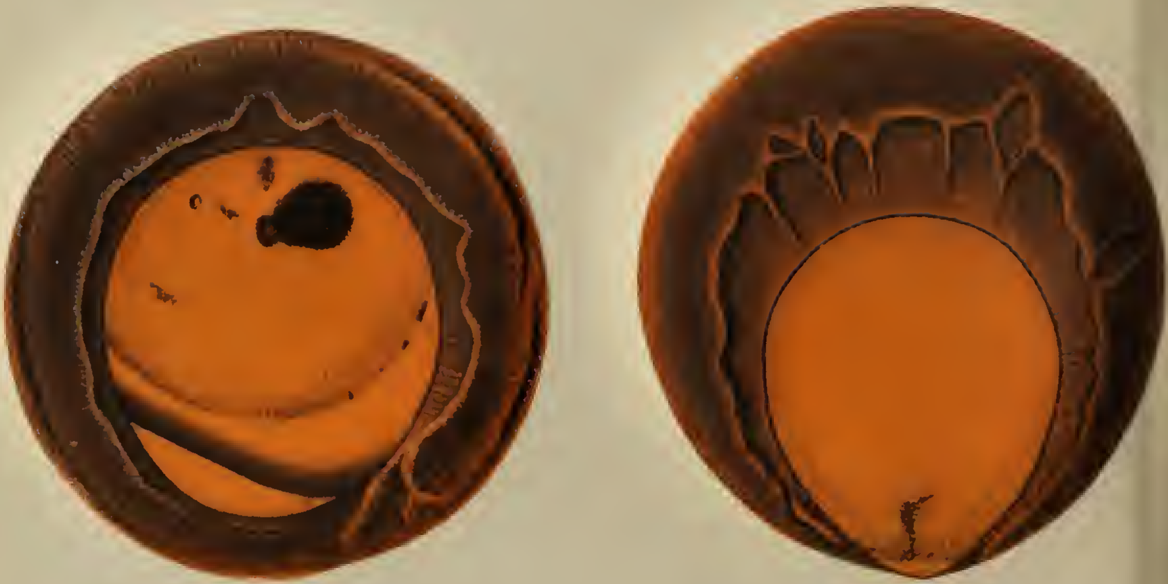
Stationary Anterior Polar Cataracts.

Showing folds in the capsule. By (a) focal and (b) transmitted light. (After Wintersteiner.)

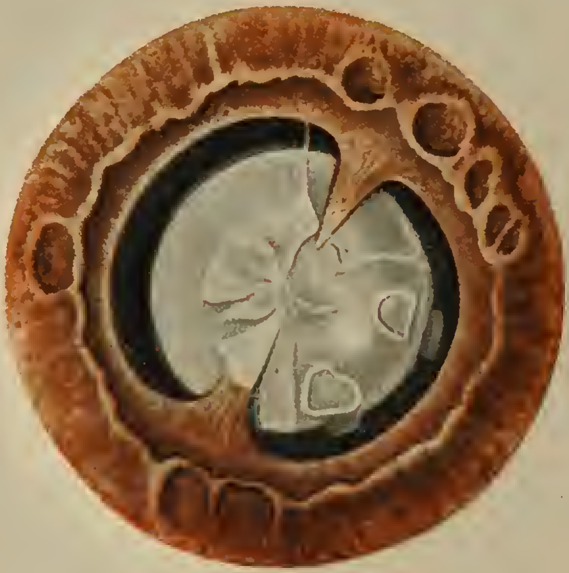


Stationary Anterior Capsular Cataract.

Focal illumination. The opacity is due to injury of the capsule during an iridectomy for glaucoma. (After Wintersteiner.)

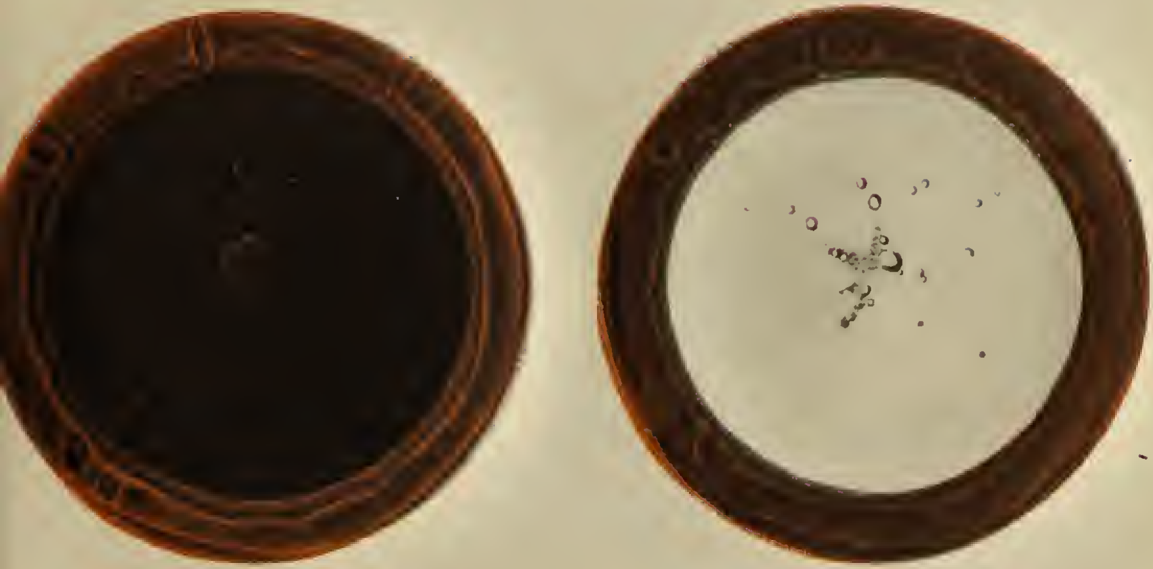


Stationary Cortical Cataract with (a) congenital ectopia (b) coloboma of the iris and choroid.
(After Wintersteiner.)



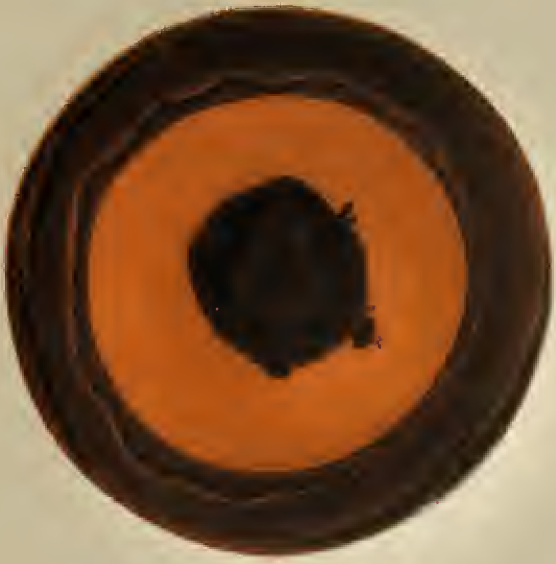
Cataract, Stationary.

Stationary perinuclear (zonular) cataract with remains of pupillary membrane. (After Wintersteiner.)



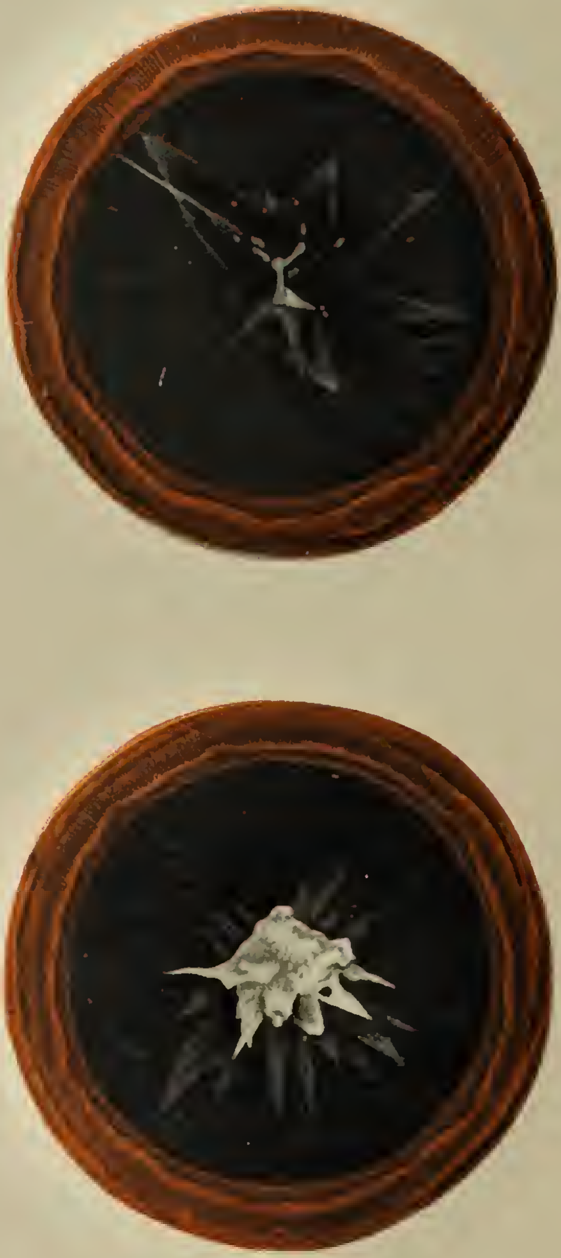
Stationary Anterior Polar Cortical Cataract.

As seen both by focal and transmitted light. (After Wintersteiner.)



Central Stationary Cataract.

Left eye, transmitted light. (After Wintersteiner.)



Stellate Cataracts.

Anterior cortical polar cataract in each eye, seen by focal illumination. (After Wintersteiner.)

Following Wintersteiner's Latin nomenclature stationary cataracts are chiefly *cataracta corticalis polaris anterior; cataracta corticalis polaris stellata; cataracta corticalis punctata; cataracta perinuclearis; cataracta centralis (seu nuclearis) congenita; cataracta corticalis polaris posterior; cataracta corticalis polaris stellata; cataracta fusiformis; cataracta corticalis anterior; cataracta corticalis posterior; cataracta æquatorialis; cataracta capsularis polaris anterior; cataracta pyrmidalis; cataracta secundaria*—all of which are described and most of them pictured under their proper, mostly English, headings. In addition there still remain a few rare or unique modifications of these varieties, notably *discoid* or *Coppock cataract,* described in this *Encyclopedia* under the latter heading, as well as by Nettleship (*Trans. Oph. Soc. U. K.,* Vol. XXVI, p. 191), and others. See, also, **Congenital anomalies of the eye.**

G. W. Thompson has abstracted (*Oph. Review,* May, 1910) the paper of Wicherkiewicz (*Clinique Ophtal.,* Jan., 1910) which discusses the *operability of stationary cataracts.* He believes the outcome of extraction is satisfactory when irrigation of the anterior chamber is adopted as part of the procedure.

With this method of operation, which he has carried out for more than a quarter of a century, he has never had any reason to find fault; and he is convinced that it is the only process of removing incomplete cataracts surely and readily. If not universally practised by ophthalmic surgeons, it is because rupture of the hyaloid membrane with loss of vitreous is feared, an accident which never happens. if his operation be properly performed.

Wicherkiewicz believes that the following cataracts lend themselves to the operation without any preliminary measures: Cortical cataract. (1) When the cortex is opaque, striated, and the fundus is no longer visible, the nucleus and the cortex can be extracted either by expression or preferably by irrigation. (2) When the cortex is segmented and swollen, extraction is usually easy, often without irrigation. (3) When the cortex is opaque, diffuse, and bluish in color, but still transparent. Here the cortex detaches itself with difficulty. A successful issue is only obtained by irrigation. (4) When the cortical striæ have disappeared and the cataract is uniform and of a bluish color. Extraction here is performed by some unusual method. Nuclear cataract. (1) Complete cataract, so-called hard cataract, comes away easily and completely. (2) Cataract hard, but incomplete. The nucleus comes away easily. When the nucleus is not large, the surgeon must be on his guard in supposing that the cataract has been entirely removed, even when the pupil appears black, because the clear cortex remains and gives trouble later on. By using oblique or artificial illumination the cortex is more readily detected, and irrigation ought to be used. Hypermature and Morgagnian cataract. (1) These are easy to remove, although sometimes unexpected accidents occur. It often happens that after cystotomy the nucleus comes away and the liquid mass remains on the iris, or the liquid part comes away readily, whilst the small nucleus falls to the bottom of the anterior chamber without budging even after attempted expression. In one or other case irrigation is indicated. *Cataract arida-siliquata.* In this variety only irrigation is successful. *Partial and stationary cataract.* These offer a large field for this method. *Cataracta stellata, punctata,* and *zonularis* are admirably adapted for linear section, plus irrigation. The pupil must be well dilated (atropin) and the capsulotomy must be large. Evacuation of lens should be by curette, or by massage (as much as possible), followed by irrigation, sometimes somewhat prolonged. Very often the pupil becomes suddenly black and remains quite free. If any lens matter remains it will be absorbed. This class of cases often gets well in ten days.

Cataract, Stellate. STELLATE ANTERIOR POLAR CATARACT. This term is usually applied to anterior polar cataract, in which a star-shaped (or six-pointed stellate) figure (see the illustration and page 1472, Vol. II, of this *Encyclopedia*), appears in the center of the pupil, just within the anterior capsule. Occasionally the posterior pole also shows a star-like opacity. It is decidedly hereditary, congenital, and generally appears in consecutive families. The anterior polar deposit is small, *stationary,* and does not interfere much with vision. The radiations in this form of cataract, easily seen by focal light, are quite distinct from those appearing deep in the cortex. When carefully examined, the star-body is found to be made up of minute dots.

Occasionally a *traumatic* cataract will assume the leaf-like form of a stellate opacity, and even retain that shape unchanged for years.

Cataract, Strumous. Cataract due to rickets or struma. *Lamellar* or *zonular* cataract (q. v.) is generally regarded as an indirect result of this diathesis.

Cataract suction operation, Hulen's. Vard H. Hulen has devised and successfully used a procedure on the new principle of *fixing the lens by a small vacuum cup* and gently lifting it out of the eye while yet contained in its capsule.

The extractor is introduced through the section from the convenient side and gently let down on the lens, making sure the cup is everywhere free of the pupillary margin so that the iris may not be subsequently pinched. The extractor being held in the operator's right hand, the left is free for use as required. The patient should look straight ahead, never down. With the cup resting over the center of the anterior capsule the nurse turns the cock at the gauge, the vacuum thus connected will cause the cup to grasp the cataract most rigidly. The extractor is then somewhat elevated and rotated to sever the supensory ligament; now with the upper edge of the cup slightly raised the cataract in its capsule is slowly and gently lifted out, passing easily through the pupil and section. See **Cataract, Intracapsular extraction of.**

Cataract, Sugar. GLYCOSURIC CATARACT. This is one of the numerous, so-called toxic cataracts produced by experimentation on the lower animals. It has long been known that either common salt or sodium nitrate, introduced in large quantities into the large intestine or under the skin of frogs, dogs, kittens, etc., produces lenticular opacities. The same thing is true of strong solutions of sugar. It is a moot question whether these changes are due to the extraction of watery elements of the lens or to an introduction of chemical substances beneath the capsule. See **Cataract, Senile**; and **Cataract, Diabetic.**

Cataract, Sympathetic. The first observer to claim the verity of *cataract from sympathetic ophthalmia* was Krukow (*Centralbl. für pkt. Augenheilk.*, IV, 1880) who related two cases that seem to be entirely convincing. Dor (*Encyclopédie française d'Ophtal.*, VII, p. 188) also reports two instances of damaged and exciting eyes, one in which removal of an ossified cataract was done and another in which a calcareous lens was extracted. Both exhibited incipient cataract in the sympathizing eye. After these operations the better eye in each instance became quiet and the cataract ceased to progress.

Cataract, Symptomatic. SYSTEMIC CATARACT. AUTOTOXIC CATARACT. A synonym of *secondary cataract* (q. v.), viz.: the form due to the presence of certain *systemic* diseases—both acute and chronic—such as typhoid fever, malaria, loss of blood, tetanus, diabetes, pellagra, chronic nephritis, diphtheria, hook-worm disease, albuminuria (see **Cataract, nephritic,** and **Arterio-sclerosis**) all of which will be found described under appropriate headings.

By some authors, also, the term symptomatic cataract is taken to include the lenticular opacity resulting from intraocular, i. e., *local* diseases of the eye. If one were to classify cataract in this fashion practically all acquired forms might be included in this one category. Although (in this connection) mention is elsewhere made of *cataract from glaucoma* it may be given here as an example of interference with the nutrition of the lens (and consequent cataract) resulting from increased intraocular pressure. At first the "greenish" appearance of the pupil (*Grüner Staar, Cataracte verte*) may be partly due to infiltration of the lens fibres with water. If the underlying disease is relieved by operation or other agency the opacity may disappear; if not, true degeneration of the fibrillæ may set in and the lenticular lesions become permanent.

So far as concerns cataract from *loss of blood*, which Pihl (*Encyclopédie Française*, VII, p. 191) reports in a case detailed by him; *cataract from dental neuralgia*, said by Wibo (*Jour. de Médicine de Bruxelles*, Dec. 29, 1904) to have been due in two cases to a trophic lesion of the ciliary body the result of reflex trigeminal irritation; and *cataract from malarial fever* which Kraisky (*Wiestnik Ophthal.* VI, 1901) insists upon, the reader will have to read the original articles and from them draw his own conclusions.

Cataract from auto-intoxication is pretty well established. From what one knows of toxic cataract, for instance that produced by ergot and naphthalin, it is not difficult to believe that autogenic toxins may be a determining cause of cataract. Bouchard (*Thèse de Lyon*, 1894) found the urine of a large number of patients with senile cataract loaded with toxic products—an observation later supported by Frenkel (*Archives d'Ophtal.* XVIII, 416) and Ducasse. Dor not only inclines to the theory of auto-infection for an explanation of certain forms of cataract but thinks the chief morbific agent to be adrenaline. In any event, these investigations serve to emphasize the necessity in all cases of acquired cataract—especially in incipient cataract (q. v.)—to have a thorough general examination made and to treat the systemic condition accordingly. (See, also, **Cataract**; and **Cataract, Senile.**)

Under various headings the rôle played by *arterio-sclerosis in the production of cataract* has been discussed. Many years ago Michel (*Festgabe für Horner*, 1881) supported the hypothesis that *atheroma of the aorta* and other large arteries is responsible for certain forms of cataract; that owing to imperfect resiliency of the vessel the blood was insufficiently supplied to the ciliary vessels. Several other observers wrote in favor of this assumption but Becker found that of 53 autopsies in which cataract was present only sixteen occurred in persons affected by aortic or carotid atheroma.

Cataract, Syphilitic. Luetic cataract. The part played by lues in the direct production of cataract, congenital and acquired, has not been definitely settled. Wicherkiewicz (quoted in *Ophthalmology*, Oct., 1913, p. 109) has discussed the question in its bearing on the production of certain forms of congenital opacity. The observation of four cases of perinuclear (lamellar) cataracts among the children of parents having normal vision, awakened suspicion of the possible relation between the ocular lesion and hereditary syphilis. The first, fifth, seventh and eighth children were affected. It is true that there was no certainty that the father was infected, nor was there observed the characteristic influence of the hereditary defect upon the continued series of births, nevertheless the absence of known causative factors and the positive Wassermann in the mother and last child seemed to justify the supposition. As to the manner in which syphilis exerts its influence, Wicherkiewicz leans to the opinion of Michel, that syphilitic lesions of the ramifications of the internal carotid, principally those which supply the retina and vitreous body, cause a disturbance of the nutrition of the lens and its partial opacification follows. See, also, **Cataract, Toxic.**

Cataract, Tetanic. CATARACT FROM TETANY. Dor believes that in lamellar (zonular) cataract (*Encyclopédie Française d'Ophthal.,* p. 182), the occurrence of convulsions, malformation of the thyroid cells and developmental defects in the enamel of the teeth form a symptomatic triad not to be ignored; and we are no more justified in charging tetany or ''strumous'' teeth with the cataract than we are in blaming the cataract for the convulsions!

The question whether tetanic convulsions are capable of producing adult cataract, possibly by an accompanying cramp of accommodation and spasmodic contraction of the ciliary muscle (or rupture of some zonular fibres), has been answered in the affirmative by Schoen, Weltendorfer, Peters, Nathan, and others who have reported cases of tetany followed by cataract. More recently, Peters found cyclitic changes in a patient suffering from tetanic cataract, and he now thinks that the lenticular opacities are probably due to these. Dor, after considering all the evidence, believes that both the cataract and the convulsions are the result of some (thyroidal) ferment circulating in the blood.

Robert Hesse and Edward Phelps have recently reported (*Zeitschr. f. Augenheilk.,* April, 1913, p. 238) on all cases of zonular cataract admitted to the Graz clinic from 1909 to date. These and patients who had formerly been operated on for zonular cataract and had returned for other reasons, were subjected to a careful neurological examination. The diagnosis of latent tetany was made if any of the cardinal symptoms, especially Erb's symptom (increase of electrical excitability) was present. Out of 43 cases of zonular cataract, arranged in tabular form, 35, i. e., 81 per cent. had undoubted symptoms of tetany, four were almost positive, which would be 90 per cent. Six out of these showed affections of the bones, but of these only two had severe rachitis, with very slight changes in the lens and no changes in the teeth. Twenty-two out of the remaining twenty-nine cases of tetany exhibited affections of the teeth. Out of the eight cases of zonular cataract without distinct tetany only one was rachitic; five had anomalies of the teeth, three not.

Hesse and Phelps did not think that *zonular* cataract the only affection of the lens in tetany, since they had observed within the last three years thirty-four juvenile patients in whom tetany existed or had previously existed; they had total cataract or some other—not perinuclear—form of partial opacity of the lens.

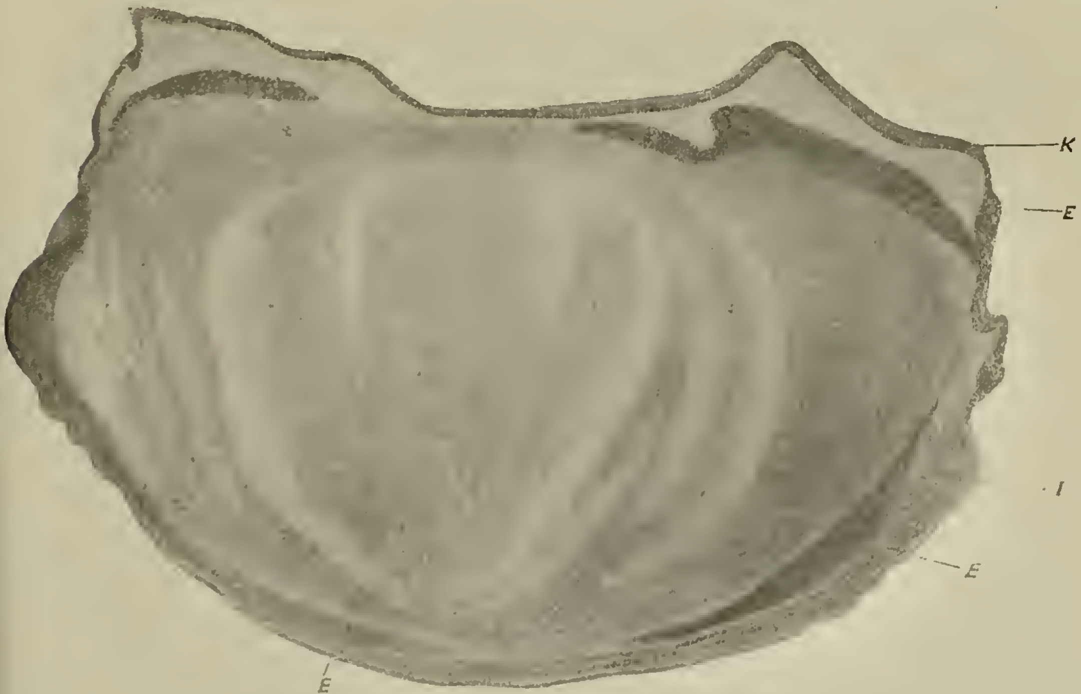
These observers concluded that it may be assumed with great probability that tetany is the etiological element of zonular and many other forms of cataract at a presenile age. They do not identify tetany with tetanic convulsions and do not attribute the cause of the affection of the lens to these. Tetanoid convulsions are only a partial phenomenon of tetany; it also presents a series of motor, sensory and vasoneurotic disturbances, and changes of metabolism from which the characteristic trophic anomalies, especially of the ectodermal structures, as skin, nails, hair, teeth, lens, develop. See, also, **Cataract, Zonular**; **Cataract, Lamellar**, and **Cataract, Perinuclear.**

Cataract, Thompsonian. A form of stationary cataract, described by J. L. Thompson of Indianapolis, Ind. It affects chiefly the periphery of the inner, lower quadrants of the lens, which may become quite opaque and yet remain *in statu quo* for many years, or until the death of the patient. The formation of a partial and stationary opacity in this neighborhood is explained by the school of Schoen (see **Cataract, Refraction**) that it is in this particular situation that most effort is exerted by the ciliary muscle fibres in their attempts to overcome the obstacles of refractive and accommodative anomalies. Dragging on the capsule injures the underlying crystalline fibres and eventually leads to changes in them.

The explanation of Schoen is not, however, that of Handmann and others. The latter observer found from an examination of 845 cases of incipient cataract that in the majority of instances the opacities first form in and spread from the lower-inner quadrant of the lens. He believed in the anatomic-pathological evidence that senile cataract is caused by disturbances of nutrition more pronounced in the lower segment of the eyeball than in the upper. The difference in intensity of disturbances of nutrition above and below is due to the fact that pathologic products, in consequence of gravitation, damage the lower portion of the lens more than the upper, and that the physiologically active rays of the natural and artificial sources of light during the whole life, strike the lower halves of the lens and retina more than the upper portions, which are shaded by the upper lids. He found in the literature only two similar observations, by Hirschberg and Greene. The opacities of incipient cataract in glaucoma and diabetes show a more equal distribution over the whole lens; in myopia there is nothing characteristic. See **Cataract, Stationary.**

Cataract, Thyroidal. Cataract from goitre. In 1898 Vossius maintained the thyroidal origin of certain forms of cataract. He regarded every case of tetanic cataract as due to the lack in the blood of the thyroid secretion or to a vitiated form of that secretion. In other words, both the lens opacity and the convulsive attacks are the result of the thyroid vice. In his own clinic (within goitre territory) he saw fewer diabetic cataracts than goitre cataracts. Of twenty-eight cases of goitre with cataract, twenty-two were binocular. Nine patients were between thirty and forty years of age, three were forty, one fifty, six sixty, and one seventy. Dor suggests that perhaps these cases exhibit merely a coincidence of goitre and cataract!

Cataract, Total. Complete congenital cataract. By these terms one usually understands a ripe, generally *senile* cataract; but Greeff (*Lehrbuch der Path. Anatomie des Auges,* p. 521) applies the name to those rare congenital cataracts that in contradistinction to lamellar



Total or Complete Congenital Cataract.

E. Space filled with exudate. L. False epithelium of the posterior capsule. K. Anterior capsule.

cataract (*Schichtstaar*) and similar forms affect the whole of the lens substance. He describes two forms, one in which the fibrillar interspaces are universally filled with droplets, the epithelium is markedly hypertrophied and the space between the latter and the lens substance is occupied by fluid. The example given of the second form of complete cataract may have been due to extra-uterine causes.

Cataract, Toxic. Raphanic cataract. Naphthalin cataract. Cataract from ergot. The production of cataract by the ingestion of various poisonous agents is a well known fact. It has been considered under the usual headings in the previous and present volume of this *Encyclopedia* and it remains only to say that every form of opacity of the crystalline from toxic agents is rare in America although cataract from ergot (q. v.) poisoning is well known in Europe.

Lewin and Guillery (*Die Wirkungen von Arzneimitteln und Giften auf das Auge,* Vol. I, p. 715) report rapid opacification of the lens from the ingestion of chloral hydrate, the lenticular cloudiness being preceded by a superficial infiltration of the cornea.

Cataract, Trabecular. This is one of the forms of fibrinous (spurious) cataract (q. v.) mentioned by Mackenzie. It has no pathological connection with the lens or its capsules, and should, of course, not be called cataract at all.

J. A. Schmidt has also applied this term to the so-called "barred" cataract, in which the opacities are supposed to be arranged like crossbars within the lenticular capsules.

Cataract, Traumatic. Opacity of the lens or its capsules due to injury is comparatively common. As a part of ocular diseases in general it occurs, according to Arlt, in 0.40 per cent. of the cases; Becker, 0.54; Schiess, 0.91; Snellen, 0.45; Knapp, 0.80; Pagenstecher, 0.90; Mooren, 0.74 and Cohn 0.43. The percentage of traumatic to other forms of cataract was estimated by Arlt to be 6.40; Becker, 9.20; Schiess, 16.4; Steffan, 4.70; Hirschberg, 18.70; Knapp, 12.50; Mooren, 14.5; Pagenstecher, 10.9; Drake-Brockman, 21.0; Galezowski, 5.0. Of course the percentage of lenticular traumatism will vary in the practice of each ophthalmic surgeon according to the extent his patients take part in dangerous occupations. For example, a clinic attended entirely by workmen in steel and iron works will probably show a high percentage of traumatic cataract.

Penetrating wounds of the eye from flying metallic splinters is the most common cause of traumatic cataract and as such the section on **Magnet operations** should be read in this connection. The *legal* questions that arise now and then, as well as the relations of these traumas to *Economics,* are fully discussed under their proper captions.

This form of lenticular opacity may be divided into two principal classes, first, cataract from various injurious agents that do not cause a breach in the ocular tunics and, second, that following penetrating wounds of the globe. The first class is the rarer and includes *concussion cataract,* cataract following blows from blunt objects on the eyeball, cataract resulting from lightning (fulguration) stroke, Vossius ring-lens, etc.—all of which are treated at length under their proper headings. (See, also, **Injuries of the eye.**)

Injuries accompanied by penetration or laceration of either the anterior or posterior capsule are by far the commonest causes of traumatic cataract.

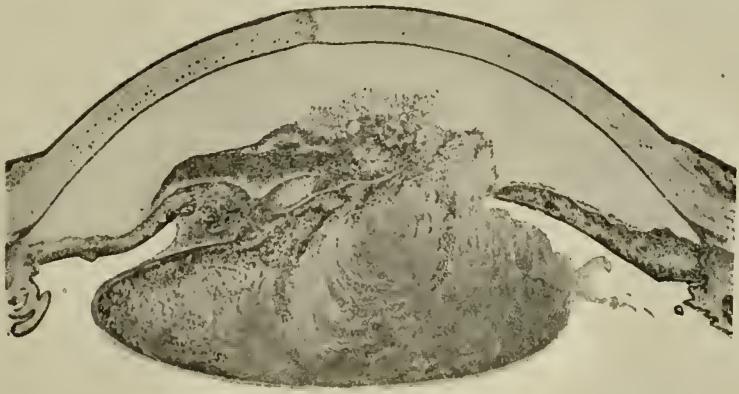
As soon as the anterior capsule is incised or ruptured to any extent the wound edges curl up and roll out. The aqueous humor coming in contact with the fibrillæ causes them to become opaque, swell up and protrude through the capsular rent. These changes generally affect the lens mass until the whole crystalline is cataractous. Parsons (*Pathology of the Eye,* Vol. II, p. 417) reports, as follows, the important experiments of Schlösser and Schirmer in this connection: they closely correspond to the changes that are found in human eyes. "Immediately after an experimental discission the iris and the pupillary area of the surface of the lens become covered with a layer of fibrin. This soon disappears except at the site of the wound, where it forms a cap over the swollen lens fibres. In the meshes of the fibrin there are a few leucocytes, often containing pigment granules derived from the iris, free iris pigment, and a few degenerated capsular epithelial cells. As long as the aqueous has access to the fibres vesicular cells are formed amongst them (Schlösser). The epithelium, like that of the cornea, is normally in a state of tension, so that the cells peripheral to the wound are pushed towards it and rapidly cover it. They cease to be regularly cubical and become flattened. It is only after twenty-four hours have elapsed that mitoses are seen (Schirmer), chiefly situated near the edges of the wound, but found also in varying numbers at a distance, and even at the equator. The new-formed cells are more regular, and push their way between the swollen fibres and the fibrin cap. Later, the epithelial cells proliferate in such a manner as to produce a mass of spindle-shaped cells exactly resembling anterior capsular cataract; these cells never show mitoses. Schlösser describes the formation of a thick mass of fibrous tissue replacing the fibrinous cap, but this is denied by Schirmer. It is probable that Schlösser mistook the nature of the spindle-shaped epithelial cells. Fibrous tissue is never formed under these conditions unless there is coincident injury of the iris or apposition of the lens to the wound in the cornea. In pure lenticular wounds there are no fibroblasts present from which fibrous tissue could be developed. The subsequent history of the scar is exactly similar to that of a capsular cataract, the nuclei and cells becoming smaller and replaced by a homogeneous matrix. Finally normal cubical cells grow in from the sides under the scar, and form a continuous single layer, which then slowly secretes a hyaline membrane in all respects the same as that found under old anterior capsular cataracts. According to Schlösser the same process occurs on the anterior surface of the scar. As in the case of Descemet's membrane, the capsule never unites directly, but only occasionally by the formation of a new cuticular membrane.''

It must not be forgotten that *transient* traumatic opacities of the lens may occur. A. Terson (*Annales d'Oculist.*, November, 1909), considers that these cases are rare. If they clear up in a week he calls them *negative* opacities, but if several months elapse he calls them *transient* opacities. He has seen examples of each type. While the text-books scarcely mention such cases many have recorded and studied them, as the literature amply shows. Contusions of the globe and minute punctures of the lens have both been factors in the etiology. The most frequent forms observed have been streaks, parallel lines, radiating stars, veins of a leaf, fine net-work, milky nebulæ, concentric rings and a wire lattice, located chiefly in the anterior or posterior cortex of the lens.

In following a prognosis we should carefully consider: 1. The duration and form of the opacity. 2. The origin of the traumatism. 3. The nature of the wound. 4. The age of the patient. 5. The ultimate result of the accident. Intermittent or delayed cataract may occur, which Panas calls post-traumatic. 6. The character of the permanent defects must be considered. A partial amelioration may show a compensating result.

We should guard our prognosis by the term ''opacity of the lens'' rather than cataract, for it may yield to alterative treatment or to nature's balm of youth. We should, therefore, be patient and prudent before considering the question of operation, as many spontaneous recoveries have been recorded.

As Weeks (*Treatise on Diseases of the Eye*, p. 589) points out, if the opening in the capsule be small, even though the lenticular substance be involved, the opening in the capsule may close and the resulting opacity may be very slight and confined to the margin of the wound canal. The lens substance may become cloudy for some distance adjacent to the wound, and the cloudiness may clear up except at the margins of the wound. A minute foreign body may pass entirely through the lens, causing only very slight opacification along the track of passage. Opacification of the wounded lens may advance to a certain degree short of complete opacification, and then become stationary, so remaining throughout life. As a rule, penetrating wounds of the lens result in complete opacification, the cataract thus formed being of a grayish-white color, and belonging to the class of "soft" cataracts. The lens substance in all traumatic cataracts from whatever cause becomes swollen from imbibition of water. In cases of laceration of the capsule, the swollen lens substance may escape from the wound,



Traumatic Cataract.

In the center of the cornea may be seen the cicatrized wound. The anterior lens capsule is torn open, and the lenticular substance has come forward into the anterior chamber through the capsular wound and is to some extent absorbed. The trauma is, however, accompanied by an infective process, whence the noticeable infiltration of the lens and iris as well as the exudates into the pupil and anterior chamber. (After Axenfeld.)

cause increase of tension (secondary glaucoma), and require immediate removal. Absorption of the lens substance after rupture of the anterior portion of the capsule progresses rapidly in the young, much less rapidly in adults. Absorption of the lens substance after rupture of the posterior capsule takes place very slowly. The vitreous humor possesses little absorbent power.

The *treatment* of this condition to some degree depends upon the age of the patient and the extent to which the lens and other tissues of the eye are involved in the injury that produced the cataract. A one per cent. solution of atropine should be instilled into the eye and it is generally well to combine it, for obvious reasons, with a 2 per cent. solution of dionin and 1:5000 of formalin. An effective mixture in these cases is also the following:

℞

Atropiæ sulph.	gr. ii
Dionin	gr. vi
Ungt. bichloridi (White)	℥ ss

After cleansing put a little into the eye with a probe as often as is necessary.

If the injured lens be seen in a person under twenty a waiting therapy of this sort may be relied upon for several weeks or months, since absorption of the lens matter sometimes proceeds quietly without further surgical intervention; or at least nothing more radical than an occasional needling will be required. In older subjects it is generally wise, especially if the opacity is progressive or the lens much injured, to remove the cataract *en masse,* by any of the usual procedures. See **Injuries of the eye; Cataract, Senile; Cataract, Juvenile.**

Cataract, Tremulous. VACILLATING CATARACT. When the zonule of Zinn is ruptured and the principal support of the lens is removed, the oscillating, cataractous lens communicates its movements to the iris so that the trembling of both organs can be easily made out, especially on motions of the head or body.

Cataract, Triangular punctate. This must be an exceedingly rare form of punctate, congenital cataract as it is not described in the usual monographs on the subject. Reference to it are confined to a few reports in periodicals. For example, George S. Crampton (*Annals of Ophthal.,* July, 1913, p. 614) refers to a case of triangular congenital cataract which he exhibited two years before. It was afterwards discovered that this nine-year-old boy was the son of deaf-mutes who were not blood relatives. In the center of each lens there was a circular, film-like cataract about 6 mm. in diameter, composed apparently of very minute dots. These formed a symmetrical triangle, base up, within the circular area, the stippling becoming so attenuated towards the center that through it practically 6/6 vision was obtained with glasses to correct the slight amount of compound hyperopic astigmatism. The uncorrected vision was 6/9 and 6/12 in the right and left eye, respectively. The eyes of his mother and sister were free from cataract, and all other members of the family were said to have good eyes, although as they lived at a distance they could not be examined.

Cataract, Triradiate. According to Collins and Mayou *(Pathology and Bacteriology,* p. 41) congenital triradiate opacities of the lens are met with both in front and behind the nucleus, and are sometimes seen on the anterior surface of lamellar cataract. They are also met with behind the nucleus in the disc-shaped opacities which are often hereditary and which have been termed "Doyne's cataract." These cataracts must be distinguished from the discoid cataracts in which the whole lens has the shape of a disc. In Doyne's cataract it is the area of opacity in a normally shaped lens which is discoid.

Cataract, Trumpet-shaped. This is a variety of coralliform cataract. Herbert Fisher (*Oph. Review,* July, 1909, p. 211) describes a bilateral case, a girl, aged 12, the third child of five, and none of the others were affected. The vision, with correction, was 5/12 partly in each eye. Each lens showed a circular dot of opacity at the posterior pole, and radiating from this six cortical striæ at symmetrical intervals. The whole appearance might be called a boat-shaped or elliptical opacity lying somewhat obliquely with its long axis approaching to the vertical; the free margin is sharply cut, and the cortical striæ show open mouths and are strongly suggestive of the trumpet-shaped opacities seen in coralliform cataract.

Cataract, Uncinariasis. HOOK-WORM CATARACT. A. W. Calhoun (*Ophthalmic Record,* April, 1904), gives the clinical histories of a number of cases of cataract occurring during the course of the hook-worm disease and where the opacity of the lens began after the establishment of the general disease.

The author believes the development of the cataract is due to the disturbance in nutrition of the lens, dependent upon the impoverished condition of the blood which is present in cases of uncinariasis and adds that if this disease predisposes the patient to cataract, the hook-worm becomes a subject of as much interest to the ophthalmologist as to the general practitioner, for in the victim of uncinariasis, cataract might become one of the preventable diseases, since it (hook-worm disease), is so rapidly and surely curable.

Cataract, Unripe. IMMATURE CATARACT. INCOMPLETE CATARACT. CATARACTA NONDUM MATURA. This subject might from the practical viewpoint of treatment be considered as an extension, a continuation of, or as a supplement to, that of incipient cataract (q. v.), or to include partial and stationary cataracts. Under what circumstances and under what conditions the surgeon is justified in agitating the patient and his family by telling him he has cataract—that most disturbing of names to the public—is not always easy to determine. The Editor's practice is *generally* to tell the *patient* the exact truth, so far as he knows it, and *always* to inform the nearest-of-kin when it is thought best to avoid speaking directly to the invalid. An important matter is to inform the patient when a few peripheral-lenticular striæ are the only changes present that "these are to be found in the eyes of most elderly people, that one does not feel like dignifying them by the term 'cataract,' that they may never interfere with vision, that one 'should not cross bridges' until they are reached and that the only reason for mentioning them at all is that if seen later by another surgeon the patient may know that they were discovered previously and were not then regarded as serious."

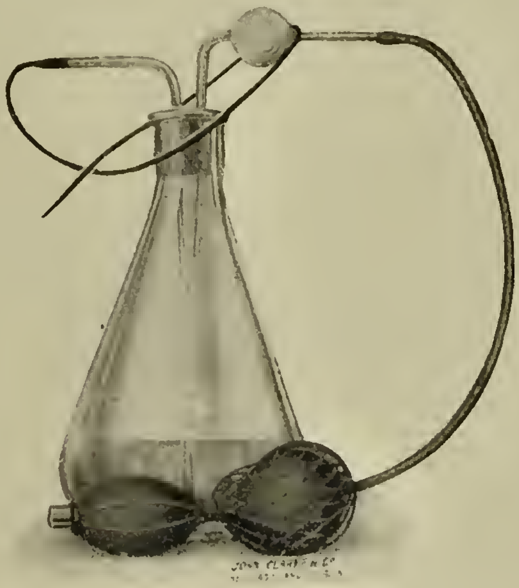
Regarding the *maturation of unripe cataract,* it may be said here (see also **Cataract, Senile**) that this procedure is to be considered in persons under sixty-five years of age when the patient has sunk so low that he is unable to pursue his usual avocation; after sixty-five the lens is generally so sclerotic that artificial ripening is not necessary. However, in all extractions of unripe cataract, that one may be able to see all the otherwise transparent, immature lens matter, it is advisable to perform a preparatory iridectomy and capsulotomy. The Homer Smith operation seems admirably adapted to this contingency. The maturation of unripe cataract has been discussed elsewhere in this *Encyclopedia* (see **Artificial ripening of cataract**) ; meantime, the reader is reminded that as early as 1811 Gibson needled unripe cataract so that the aqueous humor might penetrate the substance and prepare it for extraction. Muter (*Practical Observations on Various Methods of Operating on Cataract,* London, 1813) shortly after practised preliminary anterior capsulotomy for the same purpose. These operators were followed by Mooren (in 1858) von Graefe, Critchett, Spencer Watson, and others. Stellwag (*Neue Abhandlungen aus dem Gebiete der pkt. Augenheilk.,* 1886, p. 125) advised posterior capsulotomy, while Businelli (*Clinique Ophtalm.,* 1898, No. 8) advocated the discission of both capsules as a measure preparatory to extraction.

In 1886, Förster (*Supplement z. den klin. Monatsbl.,* 1881, p. 133) introduced his method of massage of the lens with a strabismus hook, following iridectomy, as a maturation procedure. More or less modified, this plan has been adopted by many modern surgeons. When the maneuvre succeeds the cataract becomes ripe in from three days to a week and the extraction may be safely performed three or four weeks afterwards. E. Meyer in 1884 proposed as a substitute for massage paracentesis corneæ. Rossander (1885) suggested a special spatula instead of Förster's squint hook; a plan already carried out by Boerne Bettman, of Chicago. Other operators (Parisotti, for example) have advised sclerotomy instead of iridectomy—to avoid iris prolapse—while still others report superior successes with added capsulotomies, both anterior and posterior.

McHardy (*British Med. Journal,* Nov. 13, 1904) gives some statistics favorable to this procedure. Of 800 ripening operations he had only 5 per cent. of failure to effect complete maturation of the cataract; in

1.25 per cent. of the cases it was followed by mild iritis cured by atropine; there was slight escape of vitreous in 1.5 per cent. and, finally, only 0.375 of lost vision after the extraction. Louis Dor, Sr., was also an enthusiastic believer in Förster's method and used it extensively.

Regulation of the pressure employed in direct massage of the lens is the main consideration in Förster's operation. If too much force is used an iritis, followed by posterior synechiæ, is likely to result, and the latter may require a secondary iridectomy before extraction. Premature rupture of the capsule, dislocation of the lens, abscess of the cornea, and other complications of this procedure have been reported, but if strictly carried out according to the original directions laid down by Förster and with all modern aseptic precautions, it is a most useful and successful operation. This preliminary procedure is, however, contra-indicated in atheromatous subjects (when secondary glaucoma may be feared) and in immature cataract due to choroidal disease.



Flask used for Intraocular Irrigation, M'Keown's Method.

The *intracapsular injection* of M'Keown (*The Lancet*, page 783, 1889), produces rapid maturation of unripe cataract, but the Editor, who has had some experience with this method, has not been able to convince himself that the resulting opacity is anything more than a traumatic cataract produced by more or less extensive rupture of the capsule by the point of the syringe, together with further trauma from the injection of liquid into the lenticular substance. The whole procedure is one attended by considerable risk, and it hardly seems justifiable when one has other and equally effective operations at his command. This, also, appears to have been the conclusions of Cirincione and Spataro (*Clinica Oculistica,* 1900, p. 33). They used the same method but injected a few drops of aqueous humor instead of water in 21 cases and obtained complete opacification of six lenses within six days, and incomplete results in the remainder, but the operation was complicated by 17 cases of severe iritis and two of secondary glaucoma!

It is, however, only fair to add that Killen, an assistant for 14 years of M'Keown, believes that in specially selected cases the method is a most valuable one. He gives his own experience and that of M'Keown (*Ophthalmic Review,* Dec., 1909, p. 343) as follows: In incomplete cataract the opacity has not become equal and uniform. They regarded as unripe all cataracts, therefore, which are striated, flaky, cloudy, segmented, mother-of-pearl, dotted, lamellar or partially opaque. Functionally considered, cataracts are complete when the patient cannot distinguish fingers with his back turned to the light. A lenticular cataract structurally complete is also functionally complete, while a lenticular cortical cataract may be complete functionally, but at the same time incomplete structually. Surgically considered, cataracts are complete which can be removed easily on rupture of the capsule. Pure nuclear cataract with a fairly transparent cortex is structurally and functionally incomplete, but frequently at the same time surgically complete, i. e., easy to remove, although one cannot be certain of this before operation.

Nucleo-cortical cataracts are to be considered as cortical in questions of time of operation and probable ease or otherwise of extraction, the condition of the cortex being all important, not forgetting, of course, the relation between the size of the nucleus and the size of the section.

Seeing the red of the fundus by the ophthalmoscope, and even some of its details, does not necessarily indicate, in nuclear cataract, a difficult operation, as the cortex is frequently sclerosed and then comes out whole without irrigation. Not seeing the red of the fundus in cortical cataract does not necessarily indicate an easy operation if the opacity is not uniform. In fact we may have difficulty with the cortex even in patients over 80 years of age where there is not uniform cortical opacity. The broad rule that unripe cataracts in patients over 60 can usually be easily removed owing to sclerosis of the lens is a good one, but there are many exceptions, and in these exceptions irrigation gives much assistance.

The *principle of irrigation* is the possibility of converting at the time of operation a surgically unripe into a practically ripe cataract.

The essentials of the operation are that the solution (4 grains of common salt in each ounce of distilled water) should be absolutely sterile, and of about blood-heat, that a high pressure be not used, that the integrity of the vitreous be preserved, and that the cases be suitable ones for this method. The cases likely to benefit are those chiefly of incomplete cortical cataract at any age after the formation of a nucleus, especially where a shallow anterior chamber shows cortical swelling. The cases where it is frequently unnecessary are pure nuclear cataracts, such as the amber and dark-brown varieties, where we suspect sclerosis of the cortex, even if this is still clear to some extent, from observing a deep anterior chamber. Occasionally in incomplete nuclear cataract one meets a troublesome cortex which will benefit by irrigation.

Needles and Nozzles for M'Keown's Intraocular Irrigation.

M'Keown, in his earliest work, used a syringe, but soon gave this up for the flat-bottomed Florence flask. (See the cut.) This is closed by a well-fitting cork through which pass the two glass tubes seen in the illustration. The short tube has a bulb in which a little sterile cotton is placed as a filter to the air, and only penetrates a little way into the flask well above the level of the solution. It does not require to be moved at any stage. The other tube is longer, must be pulled up above the level of the fluid during the boiling and before use pushed down again nearly to the bottom of the fluid. The stopper may be cork or rubber; the former is more manageable. The holes in the rubber cork can be enlarged most easily by rubbing them with chloroform if the fit is too tight. About a pint of saline should be in the flask, and should not much more than half fill it. The short tube has the india-rubber bellows attached, a squeeze or two of which will start the syphon action when required. The rubber tubing attached to the other glass tube is to carry the solution to the needle or nozzle. The needles and nozzles are also illustrated in their case (see the figure) and need not be described further than to say that each contains a little arrangement where the rubber tube slips over it, by which the surgeon has full control of the flow through it as he holds it between his finger and thumb during irrigation. These are sterilized separately with the other eye instruments. The "solution" is boiled in the flask over a Bunsen flame or gas ring (having first removed the india-rubber bellows), and boiling should continue till the steam has been escaping for some minutes from both of the tubes. When about to cease boiling a small clamp is put on the long rubber tube and kept there during cooling. Were this not done non-sterile air would be sucked into the tube and flask. The sterilizing should be done some time before operation, to allow time for cooling down to the required temperature. The apparatus may be kept in an incubator if desired.

One must use the bellows with very great care or one may burst the flask or put a dangerous pressure on the lens.

The procedure is divided into two stages, either or both of which may be used as the case indicates. A perfect light must be concentrated on the cornea. After the usual sclero-corneal section and iridectomy, and before capsulotomy, the irrigating needle is introduced through the wound and made to penetrate the capsule superficially. If the cortex be soft the needle enters readily and the solution diffuses itself under and near the capsule. Transparent cortex is rendered opaque and striated, flaky or mother-of-pearl substance is rapidly broken up and separated from the capsule. In soft cases the needle may be made to move about quickly, and thus assist the action of the fluid. The needle should penetrate the capsule about half-way between the corneal section and the centre of the pupil so as to avoid penetration of the edge of the lens or of the zonule. It must be kept well in front of the nucleus. The use of the irrigating needle gives us a valuable indication of the consistence of the lens. If it do not penetrate the capsule readily, but be seen instead to push the whole lens before it, we are here dealing with a sclerosed cataract, and must at once withdraw the instrument lest we dislocate the lens. We know that we shall not require any irrigation to complete the operation in such a case. In some patients the cortex becomes so semifluid during injection that a condition very similar to Morgagnian cataract is produced. Section of the capsule is now performed in the usual way and the lens delivered, after which we remove the needle from the india-rubber tube and substitute the nozzle. We have now to deal with any residual cortex by massage and further irrigation. Before commencing this the speculum must be removed, and instead the lids be kept gently separated by the fingers, the surgeon raising the upper lid while an assistant draws down the lower one. The eye must not be fixed with forceps after removal of the lens and during further irrigation or we shall probably have escape of vitreous. The heat of the fluid is tested by allowing it to flow on the back of the hand and then the nozzle, clamped between the finger and thumb, is introduced between the lips of the corneal section. This latter precaution is found necessary owing to the involuntary muscular contraction which frequently follows if one permits fluid to drop on the patient's eyelids. The fluid is allowed to enter the anterior chamber at a rather low pressure which can, if desired, be cautiously increased by the assistant slowly raising the flask. Light is concentrated on the cornea by a lens and the action of the solution carefully observed. In many cases it is seen to render opaque masses of cortex, to bring them from concealment behind the iris and to wash them out of the eye. The diffusion of the saline is much assisted by combining it with gentle massage. Where cortical substance is found to be sticky and difficult to remove we must not hurry, but give the eye a short rest by removing the nozzle, thus allowing the fluid more time to act. We may then safely continue the irrigation for a very considerable time. Failure to obtain good results in using the method may with some be due to a not unnatural timidity at this stage. When we think we have irrigated sufficiently and can find no more opaque cortex we replace the iris and if possible leave the lips of the wound in nice apposition and the anterior chamber full of saline.

The method is specially useful in the unripe cortical cases, especially such as show swelling of the cortex and the usual pearly, striated, flaky, lamellar or dotted appearance. Nuclear cataracts with cortical opacities may benefit by irrigation in the same way as the cortical varieties. Pure nuclear cataract, even when it shows a fairly clear uniform cortex, is as a rule easily removed without irrigation, although one has occasionally fairly soft cortical matter to deal with, and it is therefore wise to have the apparatus ready at hand. A deep anterior chamber in nuclear cataract points to the probability of a hard lens and contra-indicates the trial of this procedure, the attempt to use which here might cause vitreous to escape. In doubtful cases one who does not use irrigation might safely enough before operation insert a stop needle through the cornea and thus cautiously test the consistence of the lens.

In the hands of an experienced operator who has got over the trial stage of this method the immediate results are probably as good as those obtained by other surgeons of equal operative experience, while patients have earlier relief, with fewer secondary operations. M'Keown's analysis of 154 cases showing only four total failures, 145 successes with vision varying from 20/200 to 20/20, and these all cases of incomplete or unripe cataract, proves what can be done by experience and care in detail. With great care in the sterilization of the apparatus and the solution we ought not to have a larger percentage of cases of infection of the wound than by the older methods.

Suppuration is very rare, and of the few cases where we have observed it, in at least two the cause was known not to have been irrigation, while in no instance could it be traced with certainty to that procedure. A certain number of eyes show mild iritis which usually yields to simple treatment. Loss of vitreous in smaller or greater quantity is an accident which should grow less frequent as our operative experience increases.

There are certain grave risks attached to an intraocular irrigation which must be weighed against the advantages which can undoubtedly be derived from its practice, by far the most serious of these being the possibility of injuring the vitreous body even though it do not show at the time of operation. After the delivery of the lens it does not always seem possible to be sure that the delicate structures which still remain to close off the anterior from the posterior chambers of the eye are quite intact, and the degree of fluid pressure necessary to empty the lens capsule of sticky cortical matter only seems justifiable if we have good reason to be satisfied that these structures will successfully resist the penetration of saline into the vitreous chamber, or along the tissues of the uveal tract. One unfortunately meets now and then with a patient who has left the hospital with an admirable visual result, and who returns some months or years later showing greatly diminished vision. Examination reveals large floating vitreous opacities most frequently; less often, choroidal degeneration, a cloudy condition of the fundus, a pale disc, or even evidence of glaucoma.

Cataract, Uveitic. The deposits on the anterior capsule following attacks of the various forms of iritis and iridocyelitis are followed not infrequently by (uveal) pigmentary deposits on the anterior capsule and posterior synechiæ. These complications not only interfere directly with vision in some instances but affect the proper nutrition of the lens and tend to the formation of lenticular cataract. It may also be mentioned that they also render an extraction operation more difficult and add to its dangers. The uveitis that most commonly ends in true cataract is the so-called rheumatic form; luetic iridocyclitis rarely affects the lens proper. Of course, since the medical profession is learning more generally to diagnose iritis and to take advantage of atropine in this disease all forms of uveitic cataract are becoming rarer.

Dor points out the analogy between the *periodical ophthalmia* of horses and *hypopyon* iritis in men, and believes that the secondary cataract so common in the former instance may explain the production of human lenticular opacities that seem to result from uveitic processes. See, also, **Catracata accreta**; and **Cataract, Spurious.**

Cataract, Vacillating. One associated with laceration of the zonule of Zinn, causing trembling of the iris and of the cataract on movement of the eyeball. See **Cataract, Tremulous.**

Cataract, Vesicular. This (rare) variety of congenital cataract is pictured in Vol. II, p. 1472, of this *Encyclopedia,* as a few vesicle-like opacities, irregularly scattered throughout the lenticular substance.

Cataract, Vossius' annular. Vossius's contusion ring. Ring-lens of Vossius. Traumatic ring-shaped cataract. Anterior lens-ring. This rare form of traumatic cataract, usually set up by contusions of the anterior ocular segment by blunt objects, was first described by Vossius (*Ueber ringförmige Trübungen an der Linsenoberfläche nach Kontusionsverletzungen des Auges.*, Internat. Congress, Lisbon, 1906). Since the date of this description some thirty or more cases of traumatic annular opacity have been described in literature; for example, a recent article by O. Purtscher (*Centralblatt für praktische Augenheilkunde,* Aug.-Sept., 1913), gives an account of two examples of the disease with a complete discussion of the etiology, progress, and treatment of these cases. H. Gifford has also described the disease in two papers (*Ophthalmology,* Vol. V, p. 228, January, 1909; and *Ophthalmic Record,* August, 1910, p. 412).

Vossius originally described this lesion as an annular opacity about 3 mm. in diameter. It is seen through the dilated pupil in the anterior capsule after contusions of the eyeball. As Gifford says, two of his cases had a ring of brownish color, which could be made out by oblique illumination. In the other four the ring could be seen only with transmitted light and was found to be composed of numerous fine dots. The annular opacity in all these cases entirely disappeared in the course of a few weeks, leaving normal vision in all uncomplicated cases. Vossius believes the opacity to be due to sudden and violent pressure of the pupillary margin against the iris by the cornea; the brown color, where present, resulting from iris-pigment being left on the lens; while the other opacities were the result of degenerative changes in the capsular epithelium, analogous to the experimental contusion-cataract described by Schirmer (which also disappeared completely). Following Vossius, several other cases were reported in Germany. Gifford observed in his two cases numerous fine opacities all through the anterior surface of the lens, both inside and outside the ring. Caspar (*Klinische Monatsblätter f. Augheilk.,* October, 1907, p. 425). before this, had reported a case in which the lens-opacity instead of being a simple ring could be seen, on strong magnification, to be really a circular area made up of fine spots more closely crowded together at the circumference so as to give, at first sight, the appearance of a ring enclosing a clear space. Gifford further says that Löhlein (*Zeitschrift f. Augenheilk.* XX, 1908, p. 364), whose article he had not seen when his own report was written, in describing the twelfth reported case of this kind remarked: "Peripherally, especially also centerwards from the ring of opacity, the lens-surface appears very slightly opaque so that really there is present a disk-formed opacity with ring-shaped accentuation." Later, Hoeg (*Klin. Monatsbl. f. Aug.,* June, 1909, 595), reported a case in which the area within the ring showed a scarcely perceptible diffuse opacity, while toward the lower periphery of the lens there were several radial opacities which disappeared in a few days. In this paper, which contains the best résumé of the subject and literature, Hoeg points out that the original supposition of Vossius (which had been accepted by all other writers), that the opacity was caused by the cornea being pushed in so as to actually come into contact with the iris, is certainly incorrect, for the majority of cases at least. He argues that the displacement of the aqueous necessary to permit the lens and cornea to suddenly be brought together for an area of 3 mm. in diameter could not possibly be brought about without rupture of the iris or cornea; that for the production of the regular central ring by pressure of the cornea on the lens, the force would have to be applied just in the center; the body applying the force would have to be very small, to be able to bring the cornea into contact with the lens at all; and if this were possible the result would be a small opacity denser in the center than at the periphery. As opposed to these hypothetical requirements of Vossius' theory we find the facts to be that the ring is generally produced without rupture of the cornea or iris, by bodies of the greatest variety of sizes, from steel chips to hats and footballs, striking the eye from various directions. Hoeg's conclusion is that in place of the ring being produced by the cornea being pressed back against the iris and lens, it is simply the sudden elevation of the pressure in the anterior chamber which presses the iris against the lens with sufficient force to produce the ring. This theory would not be inconsistent with the application of the force from any angle and by foreign bodies of a variety of sizes and shapes.

Caspar follows Hoeg's article with the report of the first case in which a markedly asymmetrical ring has been noted. In his case the iris was prolapsed into a wound of the cornea, and the opacity in the lens, instead of being circular, was egg-shaped with the small end of the elipse toward the wound. This indicates that the pupil must have been deformed and the ring produced before the aqueous escaped, since the deformation due to the prolapse could not occur until the pressure was relaxed. In other words the case does not speak against Hoeg's theory.

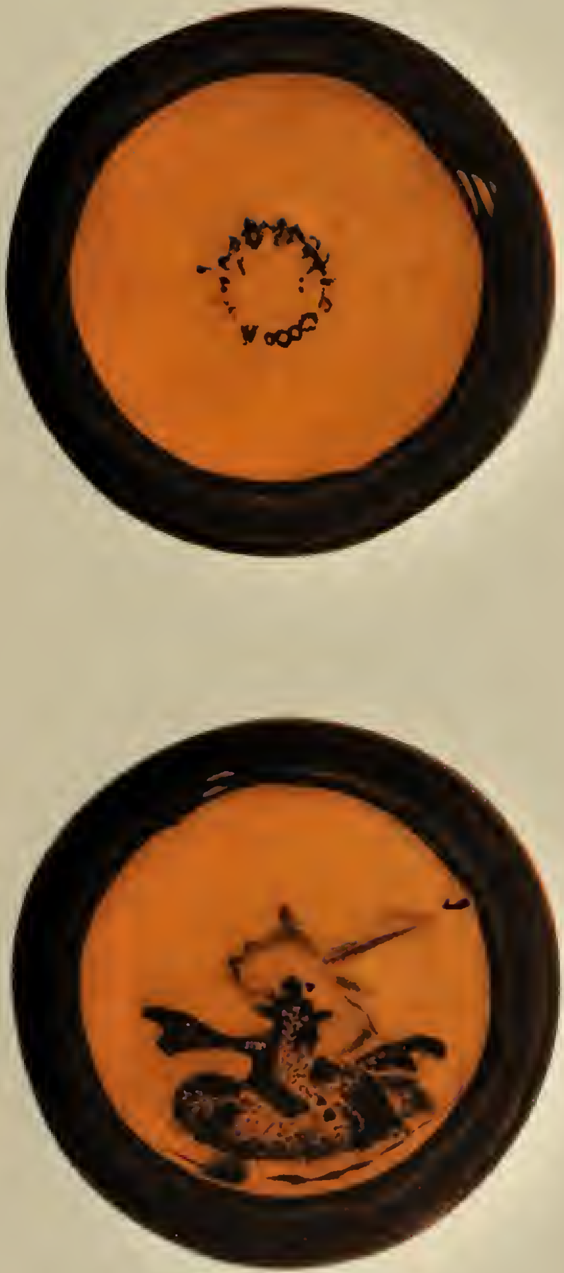
Says Gifford: "I at first accepted Vossius' explanation of the phenomenon but even if I had not seen Hoeg's conclusive arguments, I believe that the following case would have led me to seek for another explanation: On November 11, 1909, a boy of 11 years was brought to me because on the preceding evening a dynamite cap had exploded in his left hand and a fragment had injured the right eye. The examination showed several small wounds in the left side of the face and a non-penetrating wound of the inner limbus and adjacent conjunctiva of the right eye. The wound was a flat one about ⅛ inch in diameter, covered with grayish exudate. A corresponding area of the cornea was cloudy. There was a little blood in the chamber and the eye was so irritable that it was not carefully examined with the ophthalmoscope till the second day, when with the pupil fully dilated a ring-shaped opacity about 3 mm. in diameter could be seen in the center of the anterior surface of the lens. With a strong lens this ring could be seen to be made up of fine points thickly crowded together and in addition innumerable fine opacities could be seen all through the anterior surface of the lens, clear out to the periphery, as well as within the ring. With oblique illumination nothing could be seen of the ring or the other opacities. On November 29, when the boy was last seen, the ring showed decided signs of breaking up, but it could still be outlined and the fine dots in the rest of the lens could be seen also. Except for this and a stringy opacity in the vitreous the eye was normal; V. with correction, = 20/30 +.

"Here was a typical case of Vossius' ring resulting from the glancing blow of a small piece of copper at the inner periphery of the anterior chamber; an injury which could not possibly have pressed the center of the cornea against the iris. Hence for this case Vossius' explanation does not hold, and if the simple elevation of the pressure in the chamber was sufficient to produce the opacities in the lens, there is good reason for applying the same explanation to the other cases, in all of which, as pointed out by Hoeg, it is so difficult to understand how the cornea could have been pushed in far enough to touch the iris or lens. The occurrence of the opacities in the lens-surface outside the ring can be accounted for, as in the case of the ring, by the pressure of the iris; but how to account for the opacities within the ring is a more difficult problem, which I have not seen considered by any of the writers on the subject. In default of something better, I suppose we must attribute them either simply to the sudden increased pressure of the aqueous, or to a disturbance of nutrition, which the ring itself produces in the tissue within the ring.

"A case, if possible, still more convincing than my own of the correctness of Hoeg's theory is that of Steiner (*Klinische Monatsblätter für Augenheilk.,* January, 1910, p. 60), in which a typical lens-ring was observed after a shot in the temporal region, the bullet having passed into the orbit behind the eye; the latter not having been directly injured, but simply compressed suddenly from behind."

Quite recently (January 8, 1913), Clarence Loeb presented to the St. Louis Medical Society the following case: "A carpenter, while hammering a nail on January 3, 1913, was struck in his left eye. He is positive that it was the entire nail and not a piece of it or of the hammer which struck him. He was not rendered unconscious by the blow, but could not see with the eye afterwards, although his vision had been good previously. On January 6th there was circumcorneal injection, an incised wound of the cornea, and a contracted pupil with some pain. After the pupil had been dilated it was possible to see the lens. The anterior capsule was intact, but the lens substance showed a number of opacities, *arranged in a circle,* very similar to those of a beginning senile cataract, but not so far peripherally. They have become larger in the few days he has been under my observation."

George Coats (*Ophthal. Review,* Oct., 1913, p. 295) thus describes another case: A boy, aged 12 years, was brought to St. Mary's Hospital, having eight days previously received a blow on the right eye with a large piece of clay. No wound was visible, but there was a good deal of conjunctival and ciliary congestion, and hemorrhage was present, diffused throughout the aqueous, and as a deposit at the bottom of the chamber. The pupil had been dilated with atropin. Examination with transmitted light showed the presence of a small ring of opacity in the centre of the pupil, and on the level of the anterior surface of the lens. It measured about a quarter of the diameter of the dilated pupil, or slightly less, probably 1.5 to 2 mm. Its general



Ring-Shaped Cataract of Vossius.

(a) Nine days and (b) three years after a blunt, non-penetrating injury. (After Wintersteiner.)

outline was perfectly circular, but in places there was slight scalloping of the edge. With high magnification the opacity could be resolved into granules of extreme fineness; on its outer aspect it was fairly dense and sharply delimited against the clear lens substance; on its inner aspect its edge was much less defined, and indeed the whole centre seemed to be occupied by scattered, scarcely visible granules. The circle was complete, but its breadth varied, being greatest upwards and inwards. The opacity, while plainly visible by transmitted light, was extraordinarily difficult to see by oblique illumination; occasionally one seemed to catch a glimpse of a brown ring, but it was impossible to focus anything sharply with the loupe. Nothing pathological was visible in the fundus, and the other eye was normal.

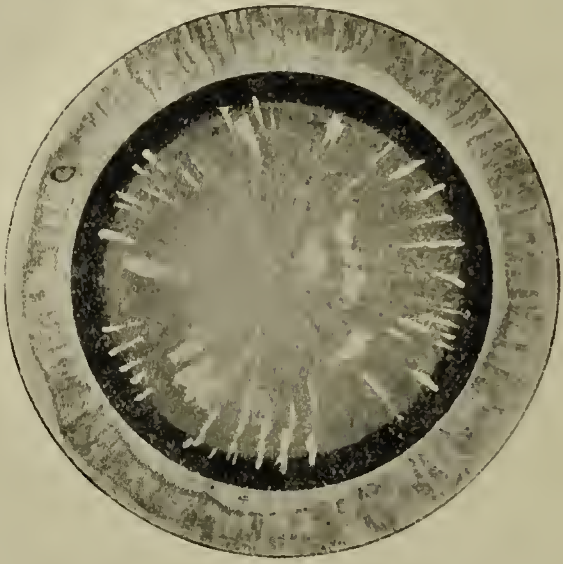
Three days later the blood had been absorbed and vision was 6/5. The pupils were equal and active; no ruptures of the sphincter. The opacity had become a little lighter, but was still clearly visible. It was impossible, however, to see any trace of it with the loupe.

T. B. Holloway has also reported (to the Section of Ophthalmology. College of Physicians of Philadelphia, Feb. 15, 1912), an instance of contusion of the globe which was followed by a well-marked example of the Vossius ring-shaped opacity of the lens.

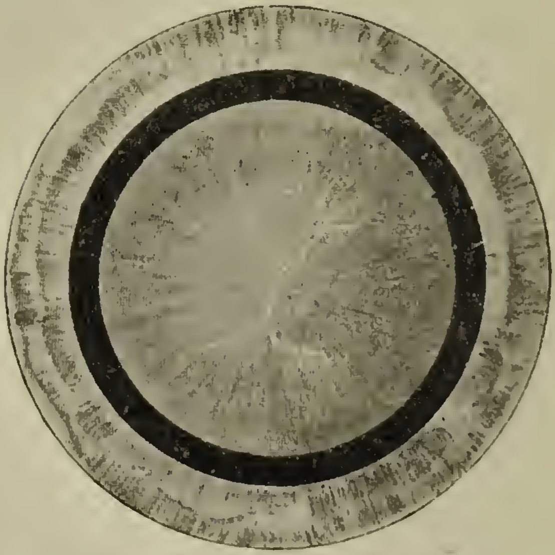
Treatment of these cases consists in protective, tinted glasses (occasionally an occlusive bandage) and atropia with hot fomentations and dionin. In most instances the ring disappears with or without treatment, but this is not always the case where there are other lesions complicating the cataract.

Cataract, X-ray. That opacities may develop in the lens as the result of injury from prolonged exposure to the Roentgen rays is a fact that has long been recognized. In 1908 Leslie Paton (*Ophthalmic Review,* p. 384) recorded the following case which may be regarded as typical of this class of cataract: M. N., aged 32, female, had good sight in both eyes six years ago. Since that time she had been under treatment for lupus of the cheek with X-rays. There had been twenty exposures on the right side and eighteen exposures on the left. The tubes used were of the old-fashioned type, made of soda glass, and the eyes had been protected by rubber sheeting only. After each application there was slight swelling of the lids, and the eyes were occasionally bloodshot and felt gritty. The vision in June, 1908 was reduced to counting fingers at about 1 metre in both eyes. In the posterior part of each lens was a dense greyish plaque, and several granular opacities were present in other parts. Cataract extraction was performed on the right eye, preceded by a preliminary iridectomy, and the vision afterwards with correction was 6/6 and J 1. A preliminary iridectomy has also been done on the left side. There was no evidence whatever of iridocyclitis in either eye. This affection may be regarded as a variety of *electric cataract* (q. v.).

Cataract, Zonular. PERINUCLEAR CATARACT. SCHICHTSTAAR. This term is a synonym of *lamellar cataract.* The various forms of this congenital opacity of the crystalline are pictured in Vol. II, p. 1472, of this *Encyclopedia.* In addition, it may be said that Greeff has given a very good description (*Lehrbuch der Path. Anatomie,* IX, p. 513) of the disease. He pictures especially those peculiar peripheral projections or spicules, extending from the opaque layer into the transparent



Zonular Cataract; Showing Numerous *"Reiterchan."*



Zonular Cataract with Stellate Figure at the Anterior Pole.

area, called "outriders" or "little horsemen" (*Reiterchen*). (See the figure.) An anterior view is also given of another lens affected by zonular cataract but complicated by a stellate figure at the anterior pole. The occurrence of "barred," "terraced," or rachitic teeth with most cases of "Schichstaar" is mentioned and compared with the presence of Hutchinson teeth as an evidence of tertiary lues in the production of interstitial keratitis.

As Weeks (*Diseases of the Eye*, p. 576) points out Max von Air collected 189 cases of lamellar cataract. In 66.07 per cent. of patients there were rachitic teeth. Schliep reported 178 cases in which 59 per cent. showed undoubted signs of rickets. A history of convulsions may be elicited in many cases. "By oblique illumination, with the pupil dilated, a more or less dense, grayish reflex will be obtained from the central portion of the lens, which is limited by a well-defined border situated between the centre and the equator of the lens. The grayish reflex is most pronounced at the equator of the opaque zone. A clearer portion of the lens is included between the partly opaque lamellæ. The red reflex from the fundus will be less pronounced throughout the affected area, the interference being greatest at the border of the cataractous area, except in cases in which the nucleus of the lens is more or less opaque, which rarely occurs. All lamellar cataracts tend to become more dense with age. Calcareous deposits may develop in the nucleus of the lens. The entire lens may become cataractous. This is most apt to occur in the cases which possess "outriders." The changes that take place advance extremely slowly—so slowly that zonular cataract is said by some authors to be stationary. If vision is reduced to $^{20}/_{40}$ it is better to remove the lens. Treatment is more satisfactory if undertaken early in life, by discission and absorption, than if later in life when extraction must be resorted to. Iridectomy is only a temporary expedient." See **Cataract, Lamellar.**

Cataratta. (It.) Cataract.

Cataratta arida siliquata. (It.) Arido-siliquose cataract (q. v.).

Cataratta calcarea. (It.) Chalky cataract. Calcareous (q. v.) cataract.

Cataratta cerulea. (It.) Blue [really punctate] cataract.

Cataratta cistica. (It.) Cystic cataract.

Cataratta dura. (It.) Senile or hard cataract.

Cataratta finestrata. (It.) A soft cataract in which the opacity is not complete, but in which there are areas of clear lens substance.

Cataratta fluida o lattea. (It.) Fluid or milky cataract.

Cataratta gypsea. (It.) Calcareous lens (q. v.).

Cataratta incipiente. (It.) Beginning cataract.

Cataratta intumescente. (It.) Swollen cataract.

Cataratta ipermatura. (It.) Hypermature cataract.

Cataratta membranacea. (It.) Membranous, siliquose or capsular cataract.

Cataratta molle. (It.) Soft cataract.

Cataratta naftalinica. (It.) Cataract produced by naphthalin.

Cataratta nera. (It.) Black cataract.

Cataratta piramidale. (It.) Pyramidal cataract.

Cataratta secondaria. (It.) Secondary cataract.

Cataratta spuria. (It.) False cataract.

Catarrh. A term of indefinite significance often applied to affections of the conjunctiva and other mucous membranes, denoting discharge from them, associated with signs and symptoms of inflammation more or less pronounced.

Catarrhacta. (L.) (Obsolete form.) Cataract.

Catarrhactes. (L.) (Obs.) Cataracts.

Catarrhal conjunctivitis. 'A simple form of conjunctivitis, whose symptoms are chiefly discharge of mucus or muco-pus, redness and swelling of the palpebral and occasionally of the ocular conjunctiva, slight swelling of the lids, smarting and a sense of ocular heat. See **Conjunctivitis, Simple.**

Catarrhalische Thränenschlauchentzündung. (G.) Catarrhal dacryocystitis.

Catarrhal ophthalmia. Simple or catarrhal conjunctivitis (q. v.).

Catarrhal ulcer. This term is usually applied to a corneal infection due to acute catarrhal conjunctivitis, or pink-eye. As Ball (*Modern Ophthalmology*, p. 253) remarks, an acute muco-purulent conjunctivitis may, if neglected, remain a long time in the subacute or chronic form. Corneal complications are rare. The development of corneal disease, characterized by an increase in pain and photophobia, begins at or near the limbus in the form of small, opaque, gray spots often arranged concentric with the corneal periphery. In a few days these points unite to form a concentric infiltration. Later the epithelium breaks down, and thus an ulcer is produced, which is known as a catarrhal ulcer. Generally it heals rapidly, leaving a minute scar, which from its location cannot interfere with vision. In rare instances such an ulcer leads to general corneal infection and perforation. Such a disastrous result is exceedingly rare in cases properly treated, but may follow improper treatment: *e. g.*, the use of poultices. In almost all cases both eyes are affected in acute conjunctivitis. In one the inflammation may be at its height, while in the other it is beginning. The *treatment* of this disease is that of simple corneal ulcer in conjunction with attention to the conjunctival disease that originally produced it. See **Cornea, Ulcer of.**

Catarrhe printanier. (F.) Vernal conjunctivitis.

Catarrh, Follicular. FOLLICULOSIS. SIMPLE GRANULAR CONJUNCTIVITIS. FOLLICULAR OPHTHALMIA. FOLLICULAR TRACHOMA. Under the above headings a chronic catarrhal inflammation of the conjunctiva, which is best seen in children, has been variously described. In children chronic catarrhal inflammation of the conjunctiva appears generally in the form of folliculosis. The disease has been so named because of the enlargement of the adenoid tissue, which takes the form of small, round, or oval translucent bodies, which are seldom larger than a rape-seed and resemble follicles. They lift up the conjunctiva, forming small elevations, and are more numerous in the lower than in the upper fornix. Often they are arranged in rows parallel with the folds of the membrane. Under a magnifying glass they look like little spots of jelly. They ultimately disappear under treatment, leaving the conjunctiva intact. In this respect they differ from trachoma. They are sometimes found in acute catarrhal conjunctivitis. This form of conjunctivitis is to be regarded as an expression of a tendency toward adenoid enlargement. The condition is extremely common. Thus, of 14,797 children, whose ages ranged from 2 to 19 years, Sydney Stephenson found only 5.55 per cent. with normal conjunctivæ; 93.99 per cent. presented folliculosis, and 0.46 per cent. had trachoma. The question of the relationship between folliculosis and trachoma has caused much controversy. It is now generally accepted by ophthalmic surgeons that they are clinically distinct diseases, although histologically there is no line of demarcation between fresh follicles and fresh trachoma bodies. In the absence of discharge from the eye folliculosis is not contagious. It tends to a spontaneous recovery without scarring of the conjunctiva. It is not associated with corneal complications, or with structural changes in the tarsal plate, and it never causes trichiasis, entropion, or ectropion. Trachoma, on the other hand, is always conditionally contagious, and is often associated with pannus, corneal ulceration, trichiasis, entropion, or ectropion. Folliculosis is rare after the twentieth year, while trachoma may be seen at any age.

The appearance of the conjunctiva in each affection may be described as follows (Stephenson): (1) *False, or follicular, granulation.* Oval or roundish, transparent bodies, the diameter of which seldom or never exceeds 1 or 1.5 millimetres. They often show a faint-yellowish hue, and are usually arranged in rows. Their tendency is to remain discrete: that is, separate from one another. They are always larger and better marked in the lower fornix. (2) *True, or "sago-grain" granulation.* Round, opaque, ill-defined bodies, of grayish-white color, and extreme friability. They are firmly and deeply imbedded in the conjunctiva, their diameter frequently reaching 2 millimetres or more. Their tendency is to become confluent, thus forming areas of trachomatous material. They are always larger and more numerous in the upper fornix.

Etiology and pathology. Follicular conjunctivitis is often said to be caused by unhygienic surroundings, but Stephenson has shown that practically no difference exists in the percentage of cases of folliculosis among the inmates of schools of good, medium, and poor social status. Folliculosis is often found among the children of farmers, among whom there is no lack of fresh air and sunlight. Among children, sex and age are without etiologic meaning. The disease, however, is often found in individuals who have enlarged cervical, femoral, or axillary glands, hypertrophy of the tonsils, adenoid growths in the pharynx, granular pharyngitis, and swollen gums. The conclusion seems evident that folliculosis is to be regarded as an expression of adenoid activity incident to childhood and youth. Some authors hold that the disease is contagious; others, that it is caused by vitiated air. The prolonged use of eserin will cause it (Juler). It is also seen after the use of atropin, particularly after the use of impure solutions. Some observers hold that dry atropin will cause it. It is probably due to a germ, but this opinion is only a supposition. Microscopic section of the enlarged follicles shows them to be composed of a mass of lymphoid cells, held by a network of connective tissue, forming an incomplete capsule.

The *prognosis* of folliculosis is favorable as regards vision, and so far as ultimate return to the normal condition of the conjunctiva is concerned; but the disease often is rebellious to treatment. In the course of years the follicles may disappear without treatment.

In considering the *treatment* of this disease it is advisable to distinguish between (1) cases without and (2) those with catarrhal symptoms. In the first class the conjunctiva often is pale, but may show arborescent vessels. It presents the oval vesiculo-grains which have been described, and there is no discharge from the eye (folliculosis of Adamiuk). Aside from attention to the general health these patients need no treatment. If the follicles are unusually abundant, the daily use of a ½-per cent. strength solution of silver nitrate, or a 10 per cent. soultion of argyrol, is advisable; or the surgeon can express the contents of the follicles with the roller forceps, a procedure which greatly shortens the period of treatment. The second class presents a mucous or muco-purulent discharge, which is rarely abundant, but is in sufficient amount to cause the eyelashes to be glued together. The conjunctiva shows the vesiculo-grains. It is somewhat reddened and slightly thickened (follicular conjunctivitis). This form demands treatment. Here nitrate of silver or argyrol is indicated. Stephenson has obtained good results from the use of a carefully prepared ointment of the subacetate of lead (1 per cent.), of which a small piece is applied to the everted conjunctiva once a day, followed by massage. After two weeks' time the strength of the ointment is doubled. Under this treatment the redness disappears, the discharge ceases, and the follicles become reduced in size and finally disappear. The use of bluestone and strong solutions of silver is not advisable in this disease. Follicles which refuse to yield can be subjected to expression, or each follicle can be touched with the fine point of the galvano-cautery. This method of treatment requires a tractable subject and great patience on the part of the surgeon. After the disappearance of the disease it will be well to search for errors of refraction.—(J. M. B.)

Catarrh, Nasal. The relations of the various phases of nasal infection to diseases of the eye are fully described under **Cavities, Neighboring, Ocular relations of.** Most forms of conjunctival infection, or conjunctivitis, are aggravated by the so-called nasal "catarrh." For example, Hanford McKee found the largest number of diplobacillus conjunctivitis in January. The dominant bacilli in the conjunctival disease are often simultaneously discovered in the nasal secretions.

Catarrh, Spring. See **Vernal conjunctivitis.**

Catarrhus siccus. (L.) Dry catarrh, generally applied to ozena and similar diseases of the nasal passages that are often associated with various forms of conjunctival disease.

Catarrh, Vernal. See **Vernal conjunctivitis.**

Catarro da atropina. Atropine conjunctivitis.

Catarro da atropine. (It.) Atropine conjunctivitis.

Catarro secco. (It.) Dry catarrh.

Catarro vescicoloso. (It.) Vesicular conjunctivitis (Arlt).

Catatropia, Double. This condition occurs when both eyes are turned constantly, or mostly, downwards. It differs from double cataphoria in which there is only a *tendency* in that direction. Both hypertropia and catatropia practically always exist as complications of either esotropia or exotropia, and not infrequently are associated with cyclotropia. Hypertropia may be double, and catatropia may be double, or there may be a hypertropia of one eye and a catatropia of the other. If there is double hypertropia without cyclotropia, the error is caused by the conjoined action of the superior recti and the inferior obliques, both of which elevate the eye, while the in-torting action of the superior rectus is counteracted by the out-torting action of the inferior obliques. If there is double hypertropia with minus cyclotropia, the chief factors in its production are the superior recti, aided, possibly, by interni whose attachments are too high. If there is double hypertropia with plus cycloptropia, the chief factors are the inferior obliques, aided, possibly, by externi that are attached too high. Double catatropia, if caused by both the inferior recti and the snperior obliques, will show no cyclotropia; if caused by the inferior recti alone, or with the aid of interni that are attached too low, there will be plus cyclotropia also; if caused by the superior obliques alone, or with the aid of externi whose attachments are too low, there will be minus cyclotropia also. A double catatropia complicated by a plus cyclotropia is caused by the inferior recti alone, and should be relieved by a division of the temporal and central fibres of both these muscles. If in such a case there is want of converging power, this would be helped by these operations; but if there is an excess of convergence, this will be made greater.—(G. C. S.)

Cateratta. (It.) An old form of *cataratta.* Cataract.

Cateratta acquisitata. (It.) Acquired cataract.

Cateratta albuminosa. (It.) (Obs.) Albuminoid cataract.

Cateratta argentina. (It.) Calcareous lens.

Cateratta azzura. (It.) Blue cataract.

Cateratta calcarea. (It.) Chalky cataract. Calcareous lens.

Cateratta capsulare. (It.) Capsular cataract.

Cateratta capsulo-lenticolare. (It.) Capsulo-lenticular cataract.

Cateratta caseosa. (It.) Cheesy cataract.

Cateratta cistica. (It.) Cystic or Morgagnian cataract.

Cateratta dentritica. (It.) (Obs.) Cataracta dentritica; a form of congenital or siliquose cataract.

Cateratta diabetica. (It.) Diabetic cataract.

Cateratta di Morgagni. (It.) Morgagnian cataract.

Cateratta discoidea. (It.) Discoid cataract.

Cateratta dura. (It.) Hard cataract.

Cateratta falsa. (It.) Spurious cataract.

Cateratta fibrosa. (It.) (Obs.) Fibroid cataract.

Cateratta finestrata. (It.) Lattice-like or fenestrated cataract.

Cateratta fissa. (It.) (Obs.) Fixed cataract.

Cateratta grumosa. (It.) Grumous cataract (q. v.).

Cateratta immatura. (It.) Unripe cataract.

Cateratta ipermatura. (It.) Over-ripe cataract.

Cateratta lamellata. (It.) Lamellar cataract.

Cateratta lamellosa. (It.) Zonular cataract.

Cateratta laminosa. (It.) Lamellar cataract.

Cateratta latticinosa. (It.) Milky cataract.

Cateratta linfatica. (It.) (Obs.) Lymph cataract.

Cateratta marmorea. (It.) Chalky cataract.

Cateratta mista. (It.) Mixed cataract.

Cateratta molle. (It.) Soft cataract.

Cateratta nascenta. (It.) Incipient cataract.

Cateratta nera. (It.) Black cataract.

Cateratta parziale. (It.) Partial cataract.

Cateratta pietrosa. (It.) Hard or stony cataract.

Cateratta piramidale. (It.) Pyramidal cataract.

Cateratta tremolosa. (It.) Tremulous cataract.

Cateratta verde. (It.) Green cataract. Glaucoma.

Cateratta vitrea. (It.) Hyaloid cataract.

Cateterismo del dotto naso-lagrimale. (It.) Catheterization of the nasal duct.

Caterpillar-hairs. As has been stated under several other headings in this *Encyclopedia,* serious injury to both the superficial and deep structures of the eye—*ophthalmia nodosa*—may be due to the entrance of caterpillar-hairs into the conjunctiva, cornea or iris. The disease is characterized by intense pain and the appearance of nodules in the tissues involved. Lacrimation and photophobia are present. Violent inflammatory symptoms supervene some weeks or months after the receipt of the injury, and iritis and iridocyclitis are frequent complications. Where nodules are found in the iris the disease may simulate tuberculosis. Often careful and repeated examinations are necessary before the hairs can be found. Excision of the nodules and the continued use of a mydriatic are called for.—(J. M. B.).

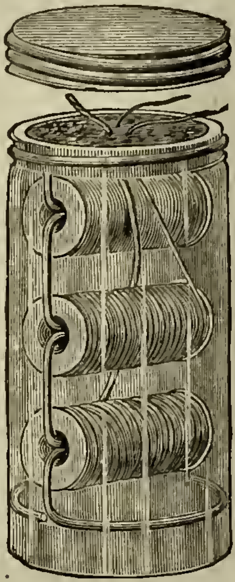
The zoological names of the animals from which the ocular structures appear to have suffered most in this way are (Lewin and Guillery, Vol. I, page 754) : *Gastropacha pini, Gastropacha trifolii, Gastropacha quercifolia, Bombyx rubi, Bombyx lanestris, Cnethocampa processionea, Lasiocampa potatoria, Lasiocampa pini, Lasiocampa quercifolia, Liparis monacha, Arcatia caja, Pieris brassicae, Portesia chrysorrhoea, Portesia auriflua,* and *Morpho metellus.* See, also, **Conjunctivitis nodosa.**

Cat-eyed. Affected with cat's-eye amaurosis. See **Amaurotic cat's-eye.**

Cat, Eye of the. See **Comparative ophthalmology.**

Catgut. In addition to the ordinary use of this substance in ophthalmic surgery for sutures, Haseltine (*Jour. Ophth. Otol. and Laryngol.*, 17, p. 271, 1911) has employed catgut rolled into the form of a ball and introduced it into the socket as a substitute for simple enucleation.

Catgut Sutures in Aseptic Fluid Holder.



Catgut Sutures Arranged in Jar Filled with Antiseptic Fluid.

Catharise. To clean anything perfectly.

Cathémérin. (F.) Returning every day.

Catheterism of the lachrymal passages. CATHETERIZATION OF THE LACHRYMO NASAL DUCT. This is but another name for the probing or dilation of the naso-lachrymal canal by means of probes or styles. See **Diseases of the lachrymal apparatus.**

Cathetometer. KATHETOMETER. A horizontal telescope, adjustable on a vertical standard, used for the accurate measurements of small differences of level.

Cathode rays. If electricity be discharged through a tube containing a gas under low pressure a greenish phosphorescence will be observed near the cathode. Plücker regarded this as due to the cathode rays being reflected back from the sides of the tube. Experiments by Goldstein and Hittorf have shown that these rays must be emitted almost normally and not as rays of light in all directions. Crooks regards the rays as streams of negatively electrified particles projected normally from the cathode at great velocity. Not only glass but many other bodies phosphoresce when exposed to these rays. E. Weidmann has discovered the thermo-luminescence effect, and others have proved that the impact of the rays produces after a time perceptible changes in the glass itself.

Cathorasis. (L.), f. n. Sharpness of vision.

Cathosis. (L.), f. n. Shortsightedness.

Catophoria. This is a rare form of vertical heterophroia in which both eyes tend to turn down when screened. There is binocular fixation when the eyes are uncovered. See **Catatropia, Double.**

Catopter. Catoptron. A reflecting optical instrument; a mirror.

Catoptrical colors. These are such as appear in consequence of a mirror-like reflection. A polished surface of silver placed in the sun reflects a dazzling light, but in this case no color is seen. If, however, we slightly scratch the surface, an iridescent appearance, in which green and red are conspicuous, will be exhibited at a certain angle. In chased and carved metals the effect is striking. If sun-light is reflected from a polished plated surface which has been acted on by aqua fortis so that the copper within is touched, and the surface itself thus rendered rough, the splendor will be reverberated from every minutest prominence, and the surface will appear iridescent. The spider's web, and mother-of-pearl are instances in nature, where we meet with these colors. The changing colors of the plumage of birds may also be mentioned here, although in all organic instances, a chemical principle, and an adaption of the color to the structure may be assumed. The appearance of objective halos also approximate catoptrical phenomena, although here refraction also must be taken into account.—(C. P. S.) See **Color sense and color blindness.**

Catoptric cistula. A box, the sides of which are lined with mirrors which reflect and multiply the images of any object placed therein.

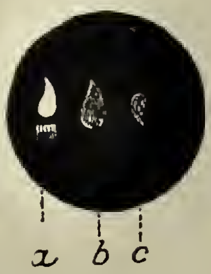
Catoptric dial. A dial which indicates the progress of time by means of a mirror so adjusted as to reflect the light towards the ceiling, where the hour-lines are delineated.

Catoptric examination of the eye. A method of examination formerly used to determine the presence and nature of a cataract, but now mainly employed to show whether or not the lens is absent or completely dislocated. See **Catoptric test.**

Catoptric images. See **Purkinje's images**; also, **Catoptric examination of the eye.**

Catoptrics. That part of physics which treats of reflected light. According to Jackson (*System of Diseases of the Eye,* Vol. I, p. 460), dioptric surfaces are also reflecting surfaces, the proportion of light transmitted through them and the proportion reflected from them varying with the substances which they separate and the angle at which the vibrations strike. Other than dioptric surfaces are also reflecting surfaces, as the polished surfaces of opaque bodies and all irregular surfaces. From a polished surface light is reflected in a definite direction, the vibrations preserving their original characters; this is called *regular reflection.* This kind of reflection enables one to see the object from which the light came to the surface. But from irregular surfaces (and from polished surfaces in so far as their polish is imperfect) light is reflected in all directions, often with considerable alteration of the vibrations. This is *irregular reflection.* It enables us to see the reflecting surface. All bodies that do not of themselves emit light are thus rendered visible. For instance, of the light thrown into the eye with the ophthalmoscope, the bulk is irregularly reflected from the retina and choroid, enabling the surgeon to see these membranes; but a part is regularly reflected from the smooth surface of the cornea and a part from the smooth surface of the retina, giving the annoying corneal reflex and the instructive retinal reflexes, both of them more or less imperfect images of the source of light.

Catoptric test. Owing to improved methods of examination of the eye, especially since the introduction of the ophthalmoscope, this test is but little used, although it has specific value in determining the absence or the presence of the crystalline lens, as well as in the diagnosis of the so-called black cataract, and the location of a lenticular opacity. The test depends upon the formation of the *Purkinje-Sanson images.* When a light is held in front of a healthy eye three images of the flame are seen. The first and second, which are erect, are produced by the anterior surfaces of the cornea and lens, respectively; the third, which is inverted is produced by the concave posterior boundary of the lens. The first and second move in the same direction as the light, while the third moves in an opposite direction. If the lens is opaque, the third image is lost, while the second becomes dimmed; if there is an absence of the deeper erect image, it indicates an opacity of the anterior capsule.—(J. M. B.)



Purkinje-Sanson Images.

Catoptrische Untersuchung des Auges. (G.) Catoptric examination of the eye.

Catoptroscope. An instrument for examining objects by reflected light.

Catotropia. This is a rare muscular anomaly in which a hypotropia of one eye alternates with a hypotropia of the other.

Catoptroscopie. (F.) Exploration by means of reflected light.

Catottrica. (It.) Catoptrics.

Cat's-eye. In geology, a variety of chalcedonic quartz receiving its name from the resemblance which the reflection of light from it, especially when cut *en cabochon,* or in a convex form, is supposed to exhibit to the light that seems to emanate from the interior of the eye of a cat. It has a sort of pearly appearance and is *chatoyant,* or characterized by a fine play of light, which is supposed to result from the parallel arrangement of fine fibers of some foreign substance, such as amianthus, or of minute hollow tubules similarly arranged.

Cat's-eye, Amaurotic. This expression is generally applied to that stage of *glioma* (q. v.) of the retina in which there are no special signs of irritation, but through the dilated pupil and clear media the growth furnishes a white reflection, something like that given out by the eye of the domestic cat. See **Amaurotic cat's-eye.**

Catulotique. (F.) Cicatrizing; favourable to cicatrization.

Cauda superciliaris. (L.) The external portion of the eyebrow.

Caudé. (F.) Caudate.

Caudiforme. (F.) Shaped like a tail.

Caustic. In *optics,* the concave-sided conical envelop of rays of light that are reflected or refracted differently in successive zones between the periphery and the center of a mirror or lens, respectively, and whose vertex, the focus of centrally incident rays upon the axis, is called the cusp. *Caustic curve,* the locus of the intersections of successive rays in any principal axial plane traced as a curve approaching and receding from the cusp. It is the region of maximum illumination or of maximum concentration of the reflected or refracted pencil of light. *Caustic surface,* a surface generated through rotation of the caustic curve upon its axis. The surface generated by reflection is called a *catacaustic;* the surface evolved by refraction being called a *diacaustic.*—(C. F. P.)

Causticazione col ferro rovente. (It.) Actual cautery.

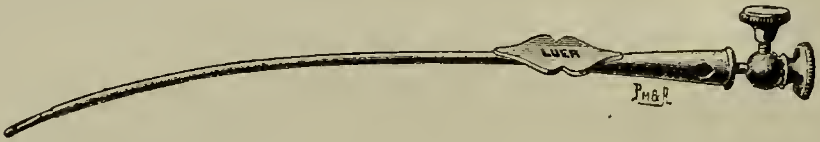
Causticazioni della cornea. (It.) Cauterization of the cornea.

Caustic burns of the eye. This important sub-section will be fully treated under **Injuries of the eye.**

Causticité. (F.) Corrosiveness.

Caustics. These agents are employed in ophthalmic surgery for the destruction of ulcers—of the cornea especially—small tumors, exuberant granulations and hypertrophied follicles. In the list of ophthalmic cauterants are glacial acetic acid, chromic acid, dichloracetic acid, hydric chloride, iodic acid, lactic acid, monochloracetic acid, nitric acid, trichloracetic acid, gold carbolate and paraiodophenol.

Iodized carbolic acid or solution of iodine in glycerine-carbolic acid, is a preparation made from iodine 20 parts, phenol 60 parts and glycerine 20 parts. Applied pure to corneal ulcers it is one of the most effective cauterants and germicides we possess, in that respect even better than pure tincture of iodine or pure phenol used alone. It is to be carefully rubbed into the stained, cleansed and cocainized cornea by means of a pointed toothpick or wooden match soaked in the fluid.



Silver Caustic Holder. (de Lapersonne.)

Carbolic acid is one of the most effective germicides in the pharmacopeia. A 95 per cent. mixture with glycerine is an excellent cautery for non-serpiginous ulcers of the cornea. After staining (see **Fluorescein**), irrigating and anesthetizing the cornea the diseased area should be thoroughly probed with the point of a wooden toothpick soaked (not merely dipped) in the solution, excessive fluid being removed from the tooth-pick with blotting paper. This procedure may be repeated several times if necessary. Inasmuch as the phenol whitens the ulcer-area it is easy to regulate the application. Success depends upon using as little as possible of the cauterant and tattooing it well into the infected spot. There is little or no destruction of true corneal substance by the carbolic acid and, consequently, a minimum amount of scarring.

Corrosive sublimate is also a useful application to corneal ulcers, in a one per cent. alcoholic solution. Stronger mixtures form efficient escharotics.

Some of the important ophthalmic caustics are copper salts, nitric acid, fused potash, silver salts, sodium ethylate, chloride of zinc, "Vienna paste" and so-called "London paste," made of equal parts of caustic soda and unslacked lime. For Vienna paste take caustic potash 5, slacked lime 6 parts and make a paste with alcohol. See, also, **Chemical cauterants** and **Escharotics.**

L. Lewin (*Klin. Monatsbl. für Augenheilk.*, May-June, 1911), divides the agents having caustic or irritating properties into two main classes: (a) Those in which there is quick action, resulting in visible primary disturbances. These are called caustics, and are divided into further sections as follows: 1. Agents having the power to *coagulate* albumen, producing acid sloughs, namely, acids, metallic salts, halogens, alkaline earths, and many synthetic products of the organic groups—phenols, cresols, etc. 2. Agents having the power to *liquefy* albumen, producing soft eschars. To this group belong alkalies of a certain strength, many metallic oxides, oxide of mercury, zinc chlorid, etc.

The second principal group (b) includes those agents which are slower to action and have no visible primary action upon the chemical tissue growth. These the author terms inflammatory agents. All mineral or animal matter, including products of the destruction of albuminoids in the body are grouped in this class.

The principal point in the first division is that the acids cause coagulation so quickly, that the effect of the necrosis is to limit penetration. Thorough and immediate washing will greatly limit the depth of the eschar. In the second group there is no immediate necrosis, but rather an absorption of the alkali by the albumen. This forms no barrier to deep penetration, as every particle of alkali albumen carries the poison to the unaffected parts. Every affected part is practically destroyed, as it can never functionate again.

The exact action of the poison of the third group is not clearly understood. The albumens are not apparently altered thereby, but there is an outpouring of blood to the affected area, an accumulation of fluid, and a process of increased functioning of various tissues with eventual secondary chemical alteration of the tissues.

As evidence of the fact that cauterizing the cornea is not always the simple remedy that it is supposed to be, the following observation is made: Eight days after a slight accidental cauterization of the left eye with hydrochloric acid, which had caused a transient erosion of the upper inner quadrant of the cornea, H. Schmidt noticed small grayish-white opacities all over the cortex of the lens. They were visible only on oblique illumination. With the ophthalmoscope the fundus appeared slightly veiled, but no distinct opacities of the lens could be discerned. V =.7, at a later examination 0.50, when the opacities appeared larger. Most likely they consisted of vacuoles and were due to the secondary action of the acid on the lens, as experimentally found by H. Guillery. The writer emphasizes the necessity, with regard to prognosis and eventual later claims of indemnity, of devoting continued careful attention to the condition of the lens, even in apparently slight cases of injuries by acids.

Causus. Intermittent fever of hot countries with gastric complications.

Cauterants. Agents that destroy the tissues by combustion or chemical action. See **Caustics** and **Escharotics.**

Cautère actuel. (F.) Actual cautery.

Cautery. See **Cautery, Actual.**

Cautery, Actual. The employment of metal cauterizing points heated red or even white is one of the most useful remedies we possess for the destruction of diseased tissue. The actual cautery was known to the ancients and was used in a variety of conditions. In modern times, the first use of the cautery in corneal ulcers has generally been credited to Martinache, who claimed to have originated the procedure, although the editors remark: "The old surgeons made such free use of the actual cautery that it would be strange if they never resorted to it for this purpose." Martinache employed an iron probe heated to a white-heat, and reported good results from its use. Samelsohn advocated the use of the cautery in certain conjunctival affections. Gayet advocated strongly the actual cautery as opposed to chemical cauterants, especially in abscess of the cornea.

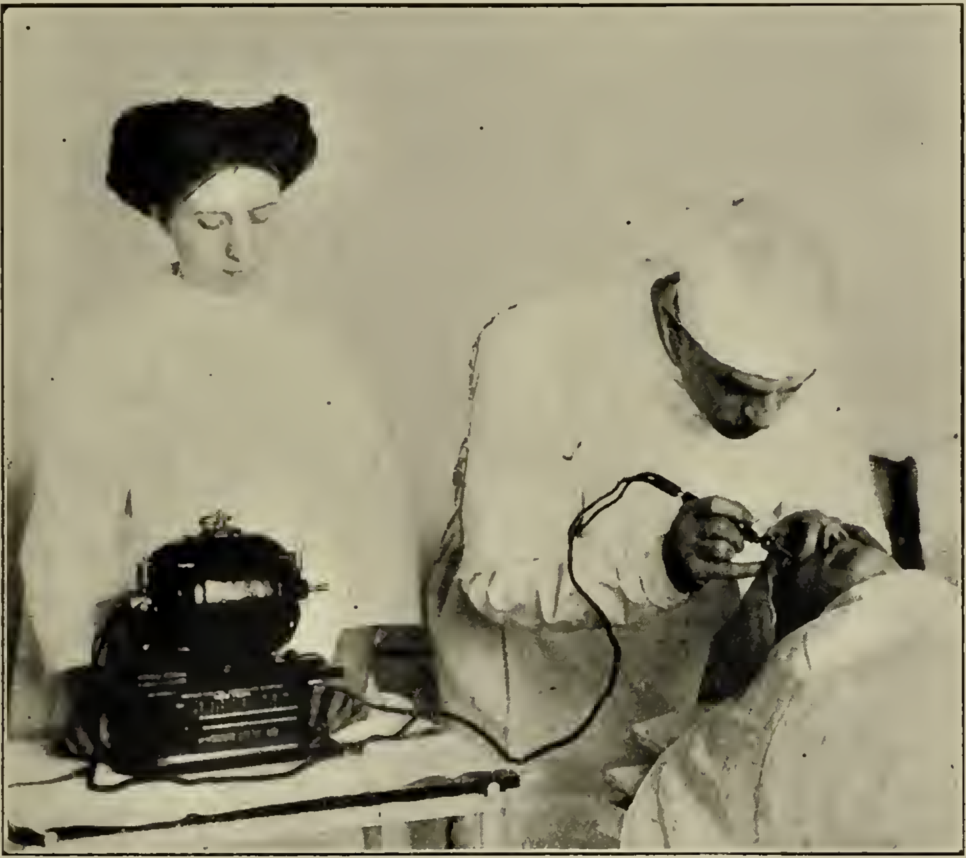
One of the earliest forms of the actual cautery is that of Wordsworth. Todd has devised a modification of Wordsworth's cautery instrument. It consists of a handle and shank with a copper ball at the end of the latter, which has a platinum point extending from it at an angle. The copper ball holds the heat so that the point is sufficiently heated to cauterize the cornea for a period of several minutes' time.

Veasey tells us that among "the more severe remedies at our disposal," should we be unable to check the progress of the ulcer, is the actual cautery, "and in few cases does the proper use of it fail to prevent the further extension of the disease."

Treatment by means of the thermocautery has been carefully considered by Teleneff.

Legroux, chief of clinic of Gillet de Grandmont, first introduced the electro-cautery, which has largely taken the place of other methods of cauterization on account of its greater convenience and efficiency. He used a fine platinum thread energized by a "*pile secondaire de Planté,*" and mentions in particular its use in phlyctenules of the conjunctiva and cornea. After this there were numerous papers on the subject, and good results reported. Neiden reported a series of well observed cases with excellent results. At the present time, the use of the cautery, and particularly the electro-cautery, has become so well established that it is a well recognized form of treatment in many ocular conditions, and has a wide share of usefulness.

In using the cautery the eye should be well anesthetized and held in the proper position, if the cornea is the seat of disease, by speculum and fixation forceps. Some surgeons prefer to lay the tip on cold and then, after bringing the tip to a dull red heat, quickly remove it. This plan is advocated by Knapp. The present writer, however, agrees with Beard, who says: "Seeing that the performance be a mere touch, it would seem that greater precision can be attained by holding the wire close to the place to be burned, heating it to the right color, then deftly making the contact." The tip should never be allowed to become white-hot, for the heat is then too great and the action of the cautery can be less easily regulated. Too great an amount of tissue may be destroyed, the light is very startling to the patient, and there is some danger of over-heating the aqueous. The point should be heated to a dull red heat, a single spot touched quickly and the point removed, and the proceeding repeated until the entire surface to be cauterized has been gone over. (See figure.)



Method of Using the Electro-Cautery.

The cautery is always used to destroy tissue, whether exuberant, infected, misplaced or malignant. The electro-cautery does everything that the actual or chemical cautery does, and does it better. It is only necessary to properly regulate its effect. Its most frequent use is for *infected ulcers,* all forms of intractable superficial ulceration, and the deeper circumscribed purulent processes, whether hypopyon be present or not. The indication par excellence is the yellowish coloration of the ulcer, which indicates a more active purulent process, although the cautery may be used with advantage in cases of ordinary "grayish" ulcer in which other forms of treatment have failed to arrest the process. In the milder forms of ulcer it is sometimes well to begin with acid cauterants, of which the most useful, in the writer's experience, is pure carbolic acid. Should other measures fail, the electro-cautery is always to be thought of in any form of corneal ulceration. In certain of the more severe deep purulent processes, considerable judgment is to be used in the amount of burning to be done. It is a general rule, in cauterizing, to destroy all infected tissue, but in the deep infiltrations of certain infected injuries, especially in those of advanced age and of the alcoholic habit, a too free use of the cautery is apt to be followed by local reaction and a further extension of the corneal necrosis, and so a word of caution is necessary. The most satisfactory results are to be expected when the infected tissue can be completely destroyed with but little destruction of the sound tissue surrounding, and without too great a lowering of the local resistance. The ulcer should always be well cleansed before cautery is applied, and in certain cases it is highly serviceable to stain the ulcer with a two per cent. solution of fluorescein which stains all the denuded surface a brilliant green and renders the field of operation clearly visible.

The cautery is very serviceable in destroying the infiltration at the tip of a vascular leash, in fascicular keratitis, and also in destroying the vessels themselves. It must first be determined that the process is an exuberant and not a conservative one, before destroying the vessels—which is to be decided by the clinical course of the case, and the constitutional tendencies of the patient, as well as the local appearances—and then the cautery is applied at the limbus so as to cut through the entire thickness of the leash. There is, as a rule, very little reaction, and the results are good. Indeed, it is surprising how little reaction follows the use of the cautery in the cornea, provided that it is used with the proper caution.

The cautery is almost essential in destroying the base of certain corneal growths after their removal. This is especially the case in corneal papilloma, as has been noted by numerous writers on the subject. It may also be used after removal of dermoids, pterygia, etc., or in any case in which the activity of the process leads one to expect a recurrence. The flat point is more useful for this purpose. After the growth has been removed as thoroughly as may be, the whole surface is lightly seared over. Knapp states that he has cauterized in this way "fully half the surface of the cornea; the recovery was by repair of almost perfectly transparent tissue, without any irritation, and there has been no relapse."

The cautery has been used in infected wounds, especially after cataract extraction. In the past this has been a recognized mode of treatment, much more so than at present when infection after cataract is, or should be, rare. The writer has used this method, but has grave doubts of its efficacy. In fact, the reaction is apt to be severe, and the infectious process is apt to continue in spite of the cauterization. Too often, as is pointed out by Knapp, the infection depends upon a conjunctival or lachrymal condition which is continuous in its effects, and the treatment of the source of the infection is of the greater importance. Besides, the local effect of the cautery seems to be to reduce the tissue resistance and at times to hasten its destruction.

The cautery has been used in certain conjunctival conditions, notably *trachoma,* but is rather a tedious method of treatment and is accompanied by a considerable amount of destruction and subsequent cicatrization. In *exuberant granulations* of the conjunctiva, low grade epitheliomas of the conjunctiva or lids, the cautery, while inferior to other forms of treatment, has nevertheless a certain value. It has also been used to obliterate the tear sac, but is a much inferior method to extirpation. Galvano-puncture is a very safe and efficient means of treatment in certain cases of angioma of the lid.

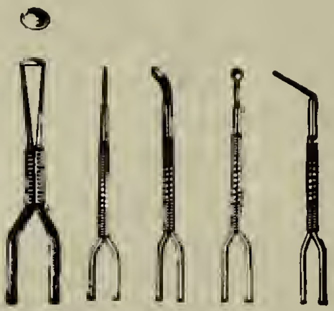
Small staphylomas of the cornea, small prolapses of the iris fistulæ of the cornea, angular incarcerations and cystoid scars, have all been treated with the cautery, and at times good results have been obtained. The iris must be approached with caution, however, on account of its vascularity and irritability. A beginning suppurative tendency is an especial indication for the cautery. (See paper by Harold Gifford, The Danger of Sympathetic Ophthalmia from the Use of the Cautery in treating Iris-Prolapse. *Jour. Am. Med. Ass'n.,* July 30, 1910, p. 386.)

In small circumscribed nodules in episcleritis, the cautery has been used by Webster for the past twenty years. A single light touch upon the summit of the nodule markedly hastens the recovery of the case and is, in the author's opinion, a valuable mode of treatment.

Keratoconus has been treated by cauterization of the summit of the cone by a number of ophthalmologists, the first of whom was A. von Graefe. His plan was to cut off a thin layer of the point of the cone and then cauterize the surface with a stick of nitrate of silver. The results were very uncertain.

Gayet advised cauterization of the cone with the electro-cautery, with perforation of the entire thickness of the cornea. Andrew advised puncture of the cone with the fine needle of a cautery. He reported a case in which the vision was improved from "fingers, with the greatest difficulty" to 20/200.

Abadie advocated cauterizing a little to one side of the center of the cone, so as to avoid giving a central opacity. Knapp reported five cases treated with the galvano-cautery, with good results. He had constructed the round point previously mentioned, and which is shown in the accompanying figure. The wires of the point led up to a disc-shaped end, which was really a section of a surface of a sphere. This was applied vertically to the summit of the cone, which is almost always below the corneal center. The current was then turned on and the point made red-hot, so as to rapidly perforate the cornea. Knapp found that without the perforation the cornea did not flatten well and it was necessary to repeat the cauterization once or twice. In one case in which a sharp point was used, perforation was accomplished very slowly, so that the aqueous "did not jet but oozed out." This case developed a very peculiar looking yellowish cataract, which Knapp believed came from over-heating of the aqueous. He says: "I had never seen such a peculiar looking cataract, apart from its developing in a young and healthy eye." Consequently, he believes that the cauterization should be done quickly, without giving time for the aqueous to heat. Critchett and Tweedy also commend the method, as does Panas. Critchett, in the report mentioned, performed the operation without perforation, while Tweedy considered perforation essential to success. Elschnig is an enthusiastic advocate of the method.

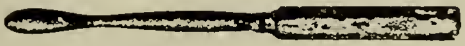


Cautery Points.

The writer, in a somewhat limited experience with this operation, is prepared to agree as to its value in cases which have gone so far as to have such distortion of the visual image that they cannot use the eye. But the after condition, with a large corneal opacity—although below the center, and possibly an inclusion, or at least an adhesion, of the iris—is not sufficiently gratifying to tempt one to perform the operation unless all other means of treatment have failed and the cone has progressed ad maximum. The vision, however, is usually much improved by the operation. With the cone fully developed, a reduction to 5/200 or 6/200 is not uncommon, while the final result after cauterization is sometimes as high as 20/50 or even 20/40. The cone flattens out well, but there is at times some diffusion of light from the opacity, and it may be necessary to perform a tattooage, or even an iridectomy.—(E. S. T.)

Cautery, Galvano or electric. See **Cautery, Actual.**

Cautery-iron, The, of ancient and mediaeval ophthalmologists. An instrument much employed in former days. Just before it was used, it was heated in the flame of a lamp or in a brazier. It was made in numerous forms. The accompanying illustration represents an ophthalmic cautery-iron, which belonged to the Gallic oculist, Gaius Firmius Severus.—(T. H. S.)



Cautery-Iron Used by Ancient and Mediaeval Oculists.

Cautery, Wordsworth's. See **Cautery, Actual.**

Cavalieri, Bonaventura (1598-1647). This distinguished professor of mathematics at Bologna, was the first to furnish a formula solving the problem, How to find the focal distance for parallel rays of light for any convex or concave lens. This formula, which appeared in Cavalieri's *"Exercit. Geomet."* (Bonan. 1647) was this: $F = \frac{2\, r^1\, r^2}{r^1 + r^2}$. Here, r^1 is the radius of the spherical surface which is toward the parallel rays; r^2 the radius of the remaining surface. The ratio of refraction is assumed to be (from air to glass) 3:2.—(T. H. S.)

Cavaliers, Petits. (F.). "Little horsemen" or "riders"—the *Reiterchen* of the Germans. Peculiar deposits in zonular cataract (q. v.).

Cavascope. An apparatus for illuminating a cavity, generally fashioned like the perforated mirror of the simple ophthalmoscope and used in the same way.

Cavernæ, Schnabel's. In the optic nerve, the result of either primary or secondary glaucoma, small pits were discovered by Schnabel, to which he gave the name *cavernæ*. Fleischer (*Bericht d. Ophth. Gesell.*, 1912) was able to find these excavations if the glaucoma were not too far advanced. Although Schnabel regarded them as the result of a primary affection of the optic nerve in glaucoma, but independent of the increased tension, Fleischer believes that the cause of the cavernæ is an accumulation of fluid, or lymph stasis, due to disturbances of circulation—and in consequence a secondary process.

Caverne. (F.) Cavity.

Cavernoma. Angioma or vascular tumor. Capaumer (*Klin. Mon. f. Aug.*, 49, II, p. 641) reports two cases affecting the lids in children aged 3 and 5 months, which healed without cicatrization after a few applications of carbonic acid snow of from 30 to 60 seconds duration. The carbonic acid issuing from the cylinder under a pressure of 45 atmospheres into a leather pouch becomes condensed to snow. This is placed in a thick glass tube (1 mm.), about 10 cm. long and 1 cm. in diameter and compressed with a piston of wood. The tube is placed on the tumor and the snow pressed on it with the piston. Capaumer recommends that we begin with short applications and prolong them progressively 60 seconds. The eyeball must be protected by a lid plate.

Cavernöse Angiome. (G.) Cavernous angiomata.

Cavernous angioma. A case of cavernous angioma is reported by A. M. Marin (*Archivos de Oftalmologia,* March, 1912), the patient being a female child of five months, and the tumor the size of a pigeon's egg. Its base occupied almost the whole of the lower lid, and the palpebral fissure and much of the upper lid were covered by the growth. Bipolar electrolysis was used five times at intervals of about a week. At each sitting the current was passed in each direction (changing the electrodes but leaving the needles in position) for two minutes, with a strength of twenty amperes. In a month the tumor had completely disappeared, leaving a smooth soft skin, bordered by some large vessels. See, also, **Angioma venenosum.**

Cavernous sinus, Aneurysm of the. See Vol. 1, page 460 of this *Encyclopedia,* **Aneurysm of the cavernous sinus, Eye symptoms of.**

Cavernous sinus, Ocular relations of the. Although the causes of thrombosis and other diseases of the cavernous sinus are generally traceable to affections of the ear, throat, nose and other accessory cavities, and, as a consequence, the subject properly belongs to the domain of the oto-laryngo-rhinologist, yet the most prominent signs and symptoms are, as a rule, ocular and frequently come first under the observation of the ophthalmic surgeon.

The cavernous sinuses, two in number, one on each side of the body of the sphenoid bone, extend from the sphenoidal fissure in front to the apex of the petrous portion of the temporal bone behind. The shape of the sinus is not unlike that of a prism with the base generally in and tilted towards the median line. In some anatomical specimens showing a very large or slightly irregular sphenoidal sinus a portion of the base of the cavernous sinus will be found above it. Anteriorly the sinuses receive the ophthalmic veins that communicate freely with each other by two, and sometimes three, smaller circular

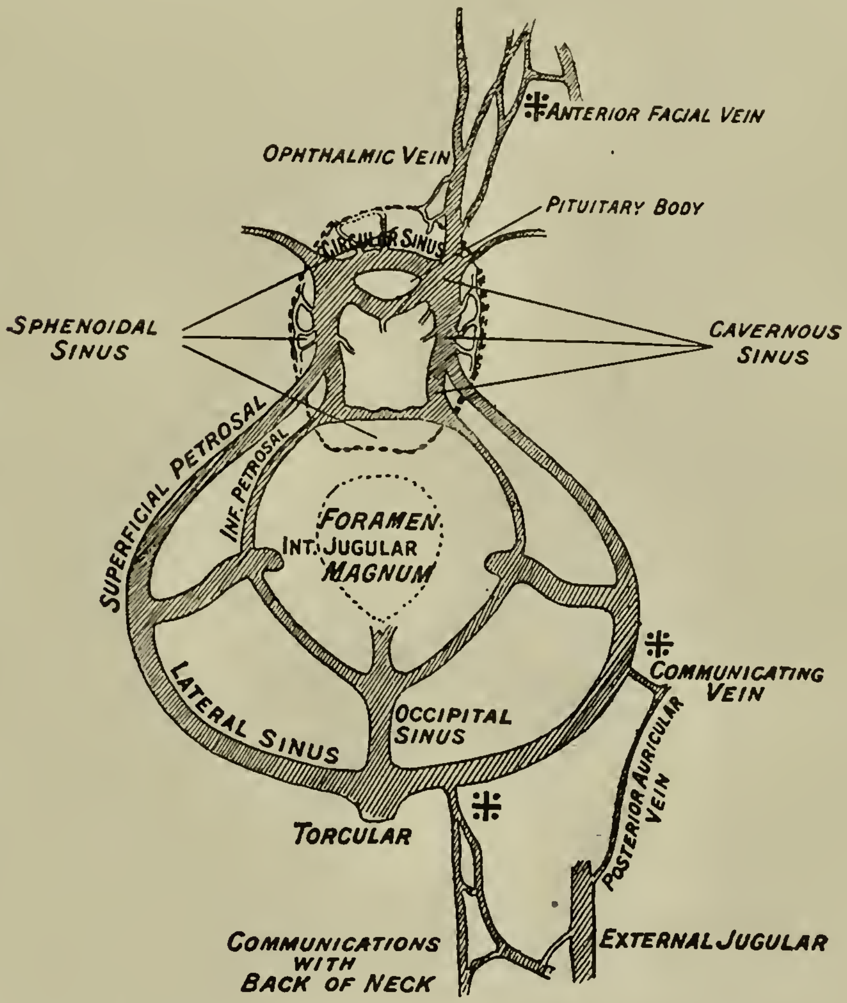
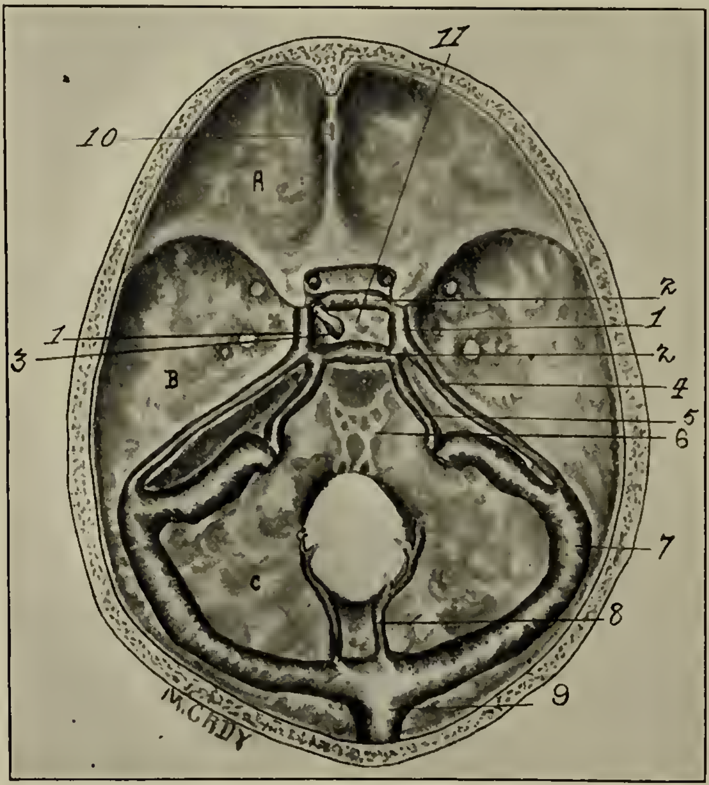


Diagram to Show Communication of Veins of Cavernous Sinus with Venous Sinuses of the Cranium; Showing Also Inter-Relation of Transverse and Cavernous Sinus with External Veins. The Asterisks (*) Mark the Anastomoses of the Intra-Cranial Venous System with the Veins of the Surface. (Modified from Leube by St. Clair Thomson.)

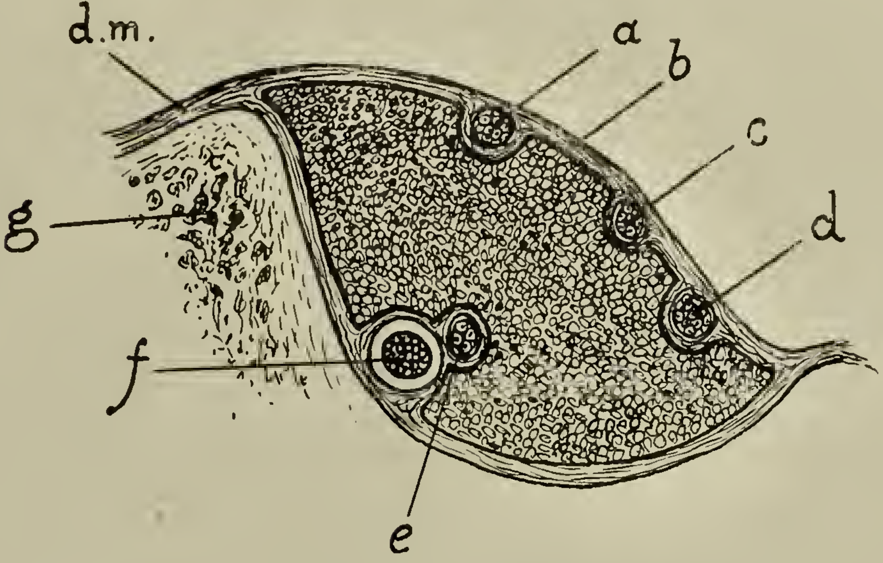
sinuses partly enclosing the pituitary body, and posteriorly terminate by dividing into the superior and inferior petrosals. They also receive veins from the inferior surface of the frontal lobes of the brain and from the middle cerebral veins. Below they communicate with venous plexuses of the neck. The chief function of the cavernous sinus is to convey the venous blood from the ophthalmic vein system about the orbit and face backwards along the petrosals to the lateral sinus and internal jugular bulb. Each sinus is quite large and is divided by fibrous bands into lacunar cavities, but always showing one main or distinct channel. An idea of their considerable size may be had when it is understood that the internal carotid artery and sixth nerve pass through the sinus along the inner wall while in the outer wall lie the third, fourth and ophthalmic division of the fifth cranial nerve. On its inner surface the cavernous sinus is separated from the



Base of the Skull (superior surface) Showing the Cranial Sinuses.

1, Cavernous sinuses. 2, Circular sinuses. 3, Curette passed from the nose beyond the roof of the left sphenoidal cavity and perforating the cavernous sinus at its junction with the circular. 4, Superior petrosal sinus. 5, Inferior petrosal sinus. 6, Basilar plexus. 7, Lateral sinus. 8, Occipital sinus. 9, Torcular Herophili. 10, Crista galli. 11, Fossa for the pituitary body. (*a*) Anterior fossa. (*b*) Middle fossa. (*c*) Posterior fossa. (Langworthy.)

air in the sphenoidal sinus by the thinnest of bony partitions. Indeed, the inner wall is applied so closely to the bone that an opening made from below upwards, cracking the sphenoidal roof laterally, is very apt at the same time to penetrate the cavernous sinus itself. The Gasserian ganglion is also in intimate relation with the sinus, being lodged in a depression near the apex of the petrous portion of the temporal bone. Every now and then one cavernous sinus is found either rudimentary or absent altogether, showing that a single sinus can, if need be, perform the functions of both.



The Relative Position of the Structures in the Right Cavernous Sinus, Viewed from Behind. (Willson.)

(a) Third nerve; (b) Lining membrane of cavernous sinus; (c) Fourth nerve; (d) First division of fifth nerve; (e) Sixth nerve; (f) Internal carotid; (g) Sphenoid bone; (d. m.) Dura mater.

While a correct *diagnosis of diseases of the cavernous sinus* depends mainly upon its orbital and ocular manifestations, nevertheless, the surgeon will often be forced to utilize every item of general information which it is possible to obtain about the patient, in order to feel sure of his ground. So many factors enter into the causation of symptoms, some of which may be masked by the advent of septicemia or of pyemia, that confusion is apt to occur if too much reliance be placed upon the presence or absence of any one particular sign. The only exception to the foregoing statement is the early occurrence of chemosis of the lids, exophthalmos and paralysis of a nerve within the sinus on the same side as an infective lesion, and the final and still more charactistic symptoms of involvement of the other eye by lid swelling and exophthalmos, as well as the occurrence of bilateral optic neuritis, if the sufferer lives long enough for this last symptom to show itself. With these facts in mind, therefore, the strictly *ocular relations of thrombosis of the cavernous sinus* may be more carefully analyzed.

Symptoms. Pain about the eyes with severe headache, either frontal or occipital, is often the first symptom to call attention to the eyes in any way. The head pain is usually deep-seated, and not constant as to location or severity. When the headache or pain is more or less unilateral (favoring the affected side) the cause may be ascribed to irritation of the first branch of the trifacial (ophthalmic division of the fifth nerve) lodged in the outer wall of the cavernous sinus.

In addition to pain, slight *tenderness of the eyeball* upon pressure with the finger, latent *ocular discomfort* or slight difficulty and *pain on swallowing* may all be admitted upon inquiry. As the disease progresses, however, the question of pain does not seem to take on important aspects even though the patient's mind may be clear until very near the end.

As *complete paralysis* or slighter degrees of disturbance of some one or all of the cranical nerves in close proximity to a thrombus within the sinus possesses a never-failing significance, a short study of these nerves is imperative for any clear understanding of the condition. With this in mind the anatomy of the cavernous sinus and its relations to the nerves within and about it may be briefly epitomized.

The sinus itself is a reticulated channel for the passage of venous blood from the region of the ophthalmic vein backward towards the internal jugular vein of the neck, and it lies within the cranium behind the apex of each orbit. Along the inner wall, actually within the sinus, runs the internal carotid artery, accompanied by the abducent or sixth nerve, while, buried in the outer wall, are found the third, fourth and ophthalmic division of the fifth cranial nerves. These nerves are separated from the blood stream flowing along the sinus only by the delicate, inner, venous lining common to all veins. For that reason disturbances within the sinus may be quite quickly communicated to them.

For practical purposes of diagnosis it is to be noted that the sixth and third cranial nerves bring about the greatest objective changes in the position of the eyeball; hence they may be considered the most important for study.

The sixth cranial nerve supplies the external rectus muscle. After piercing the dura mater on the basilar surface of the sphenoid bone the nerve runs through a notch below the posterior clinoid process and enters the cavernous sinus. It then passes through the sinus, lying on the outer side of the internal carotid artery, to enter the orbit through the sphenoidal fissure. The result of paralysis of this nerve is *internal or convergent squint,* a very early symptom in many cases of cavernous sinus disease. In the early stages of the disease it is not difficult to distinguish slight impairment in the action of the muscle involved even though there may be beginning general fixation of the globe from orbital swelling.

The third cranial nerve supplies all the muscles of the orbit except the external rectus and superior oblique besides sending motor filaments to the iris and ciliary muscle. This nerve passes along the outer wall of the sinus and enters the orbit through the sphenoidal fissure. Paralysis of the third nerve from pressure results, if complete, in drooping of the upper lid or ptosis due to weakness of the levator, external strabismus (on account of the unopposed action of the external rectus muscle) and, finally, dilatation of the pupil as the sphincter fibres of the iris become involved. It is worth repeating at this point, however, that too much stress should not be laid upon an absolutely typical picture of complete paralysis of the third nerve, as occasionally only a part of the nerve is paralyzed and nerve irritation, with resulting spasm of either a single ocular muscle or of the sphincter of the iris supplied by non-paralyzed fibres, may modify the picture.

The fourth nerve (patheticus) supplies the superior oblique muscle. This nerve is contained in the outer wall of the sinus between the third and ophthalmic divisions of the fifth. The fourth nerve when paralyzed causes loss of function in the superior oblique muscle so that there is *inability to turn the eyeball downward and outward.* When this motion is attempted the eye is twisted or rotated inwards tending to produce diplopia or slight giddiness. Examination will bring these features out in some cases. The above symptoms, however, do not seem to be constant.

The first or ophthalmic division of the fifth nerve passes along the outer wall of the cavernous sinus, below the other two, and is distributed to the eyeball and the integument of the eyebrow and forehead. Unilateral pain and numbness of skin areas supplied by this division of the fifth may be encountered in cavernous sinus disease.

The pupil is not as a rule affected in the early stages of cavernous sinus thrombosis. Late in the disease it becomes dilated and fails to react to light and accommodation. Sometimes, however, the pupil is contracted. As bearing on the matter of pupillary changes it may be mentioned again that although complete paralysis of the third nerve ordinarily produces dilatation of the pupil and external strabismus if the paralysis is incomplete, irritation of non-paralyzed fibres may cause a spasmodic condition of certain structures, such as the internal rectus muscle or fibres of the iris, which may account in great part for the miosis and internal squint reported in some cases, instead of the classical symptoms ordinarily expected.

Diplopia is in a few cases one of the early symptoms and is often due at first to affection of the fourth nerve. More commonly, however, diplopia results from displacement of the eye as a whole (with defective mobility) and is the result of increasing orbital cellulitis. Frequently the patient may not complain of diplopia at all.

The ophthalmoscopic evidence (fundus changes) of venous stasis is present in practically all cases of cavernous thrombosis, but not as a rule early in the disease. It is not uncommon to observe cases for several days before any reliable fundus changes take place. Ordinarily a *bilateral optic neuritis,* showing moderate blurring of the disc-margin with enlargement and tortuosity of the retinal veins eventually appears. Often there is well-marked choked disc with great swelling of the papilla, von Graefe believed the optic nerve-head swelling to be due to compression of the cavernous sinus), retinal edema, engorgement and tortuosity of the retinal veins and retinal hemorrhages. While in one or two instances optic neuritis has been observed only on the affected side, as a rule the bilateral character of the neuritis is one of the most characteristic symptoms of the disease. Occasionally a good view of the fundus may be observed by haziness or ulceration of the cornea, the result of lid pressure on the protruding eye.

While more information is needed on the subject of the color sense and the limits of the visual field in sinus thrombosis yet a rough examination (when possible to make it) shows that the former is not particularly affected, while the visual fields are rarely more than slightly diminished. In other words, the optic nerve or chiasm does not suffer from sinus disturbances early in the affection, which would naturally be the best time for a satisfactory test.

Central vision in the early stages of thrombosis is fairly good. As the disease progresses, however, sight rapidly diminishes and in two cases of reported aseptic or marasmic thrombosis which recovered, the sight was greatly reduced in one and the eye left permanently blind in the other.

Orbital edema with *protrusion of the eye* and *chemosis of the lids* are the most characteristic symptoms of this disease. The orbital swelling or congestion, beginning at the back of the orbit, pushes the eyeball forward so that some exophthalmus is usually present almost as soon as chemosis of the lids. The skin of the lids and of the temple also takes on a dusky hue, due to venous engorgement. If, while waiting at this point for two or three days to make certain that the cavernous sinus is or is not involved, the second or opposite eye becomes affected (chemosis of lids and exophthalmus) the diagnosis may be regarded as settled. When exophthalmus and chemosis of the lids of the second eye occur in from one to six days after its appearance in the first and is easily seen to have arisen from some disturbance behind the eyeball and not to have extended across the forehead or bridge of the nose one knows he has a cavernous sinus infection to deal with. Occasionally, orbital cellulitis of the eye first affected results in abscess, which may discharge spontaneously but without any helpful influence on the general progress of the disease.

Thrombosis of the cavernous sinus is usually the result of septic infection. Occasionally a marasmic or septic thrombosis may involve a cerebral vessel and particularly the longitudinal sinus, but this last condition is rather more of medical than surgical interest. Septic thrombosis occurs in two ways, first, by direct contiguity from adjacent bone disease or, as is more frequently the case, from extension of organized thrombi through tributary veins. The petrosal sinuses and ophthalmic veins are the principal offenders.

A brief study* of the anatomy of the region will quickly show that infection is possible from any of the following four directions:—From above (and rarely) by traumatic inflammation (following the superior longitudinal sinus and cerebral veins); from below, by caries of the sphenoid bone and posterior ethmoid cells and through the *foramen ovale* from the pharynx; anteriorly by infective processes in the orbit or face, passing backward along the ophthalmic venous system; and, lastly, by sepsis originating posteriorly, as from the ear, being carried forward against the venous blood current along the petrosal to the cavernous sinus.

The lateral sinus and internal jugular vein are usually first affected in cases of otitic origin, the thrombosis extending from the lateral into the superior petrosal sinus. It is further possible to have a thrombosis of the cavernous by way of the petrosals with only a small thrombus in the upper part of the sigmoid curve; or, if the *tegmen tympani* be perforated, the superior petrosal sinus may be directly involved. In caries of the petrous portion of the temporal bone the veins emptying into the inferior petrosals present another means of extension of the disease. Sometimes, with perforations through the anterior bony canal wall of the external auditory canal or a line of suppurating cells far forward in the zygoma, the veins of the diplöe (passing inward

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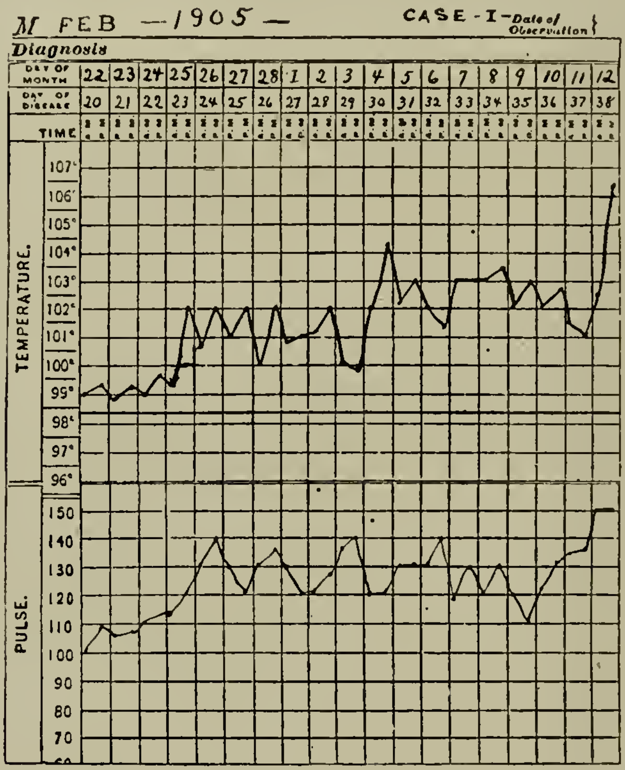
* No reference has been made to literature older than Dwight-Germain's paper in the *Boston Med. and Surg. Jour.*, May 1, 1902. From that date to the present the principal writers who have contributed to the subject are as follows: Chance, Jack, Verhoeff, Cushing, 1903; Elliot, Miles, 1904; Luc, Werner, 1905; Langworthy, Arnold, Knapp, St. Clair Thompson, Zentmayer, Weisenburg, 1906; Seggel, Snell, Langworthy, 1907; Simpson, 1908; Neumann, Stephenson Jackson, 1909; Coffin, 1910; and Hull, Ballance, and Martin, 1912.



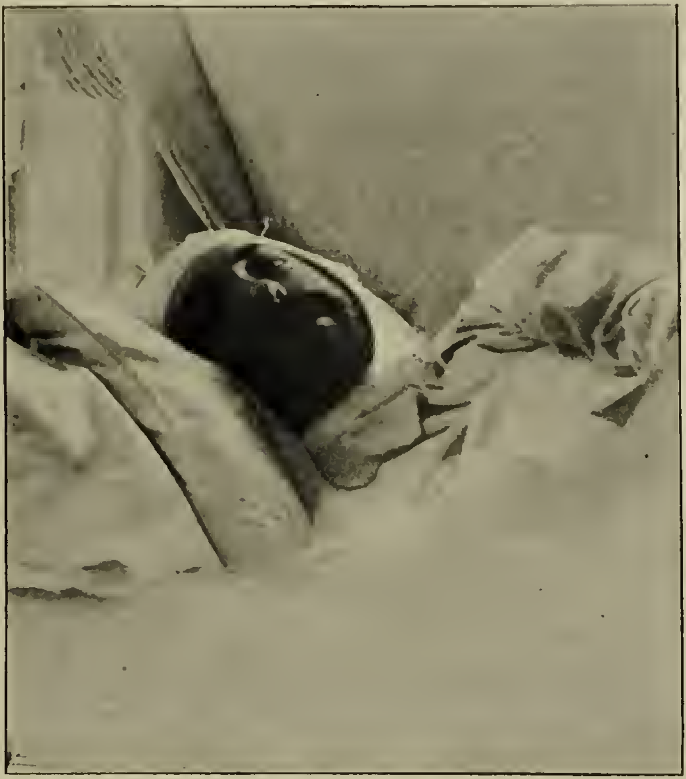
Temperature Chart in a Case of Septic Thrombosis of the Cavernous Sinus of Otitic Origin.

The first rise in temperature is suggestive of early infection of the lateral sinus, while the higher temperature a little later represents beginning cavernous involvement. (Langworthy.)

through the internal table) may be carriers of infection. Of a number of reported cases the original source of infection is, in frequency of occurrence, about as follows: ear, face or lips, mouth or throat, nose, eye, neck. The infecting microorganism may be any one of the pus-producing bacteria, the staphylococcus, streptococcus, pneumococcus and diplococcus intracellularis being the most important.

Morbid anatomy. At autopsy there is usually found an extensive leptomeningitis at the base of the brain. The dura in the immediate neighborhood and along the path of the infection is thickened and discolored. The brain itself may be in a fairly healthy condition.

There is marked erosion of the bone everywhere in contact with the cavernous sinus, and caries of the roof of the orbit. The discoloration of the bone is a prominent feature, varying from livid green to black. The body of the sphenoid is sometimes softened to a considerable degree, the bone spaces being infiltrated with pus. Distinct bubbles of gas sometimes escape when an instrument is forced into the necrotic bone. The cavernous sinuses are partly disintegrated. Extra-dural abscess may be present. Both petrosals, lateral sinus and internal jugular vein are found thrombosed. Extensive caries of either petrous or squamous portion of the temporal bone, or perforations through the tegmen tympani and anterior canal wall, are usually present in aural cases. There may also be marked caries in the region of the jugular bulb. The lungs quite frequently show pneumonic patches.



Cavernous Sinus Thrombosis of Otitic Origin Early in the Disease Some Ten or Twelve Days Before Death.

In this case the eye symptoms, chemosis of lids and exophthalmos, first appeared in the opposite eye—a most unusual circumstance. (Langworthy.)

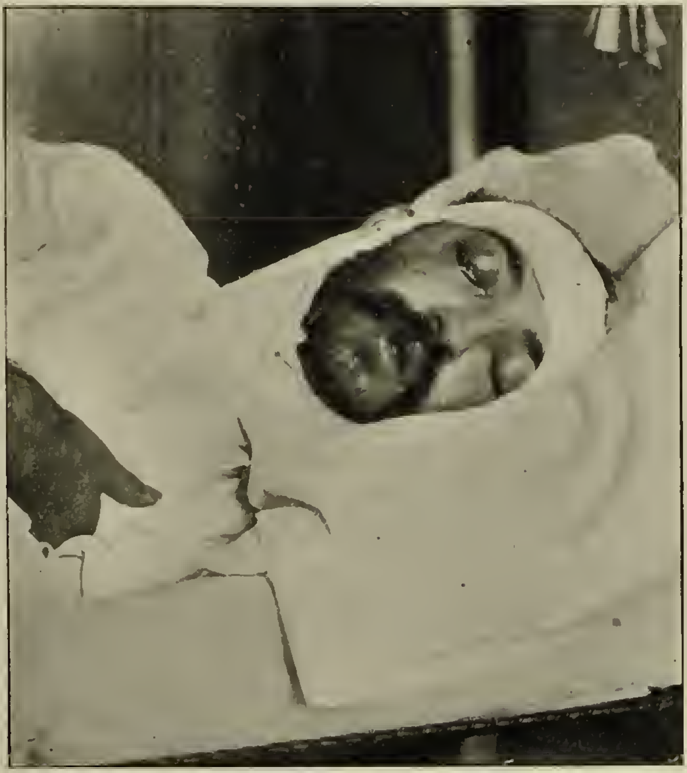
The following selected autopsies will serve to give an even better picture of the pathology in some instances. In one case, reported by Dwight-Germain, due to spreading carbuncle on the back of the neck, autopsy showed a softened thrombus affecting the left lateral sinus, the petrosal and both cavernous sinuses. All the small sinuses around the pituitary body were enlarged and filled with pus. Pressure on the eyeball forced pus out of the orbit, apparently along the tract of the ophthalmic vein. There was abscess of both lungs; in fact septicemic infection with staphylococci.

In a second case recorded by the same authors, due to infection of the right frontal sinus, the post-mortem examination showed extension of the inflammation into the orbit and ethmoid cells, septic thrombosis of both cavernous sinuses and circular sinuses attended by broncho-pneumonia. There was no meningitis, and other sinuses were not affected. Cultures showed growths of streptococci.

In a third case, reported by E. E. Jack, of cavernous sinus thrombosis following the grippe (with autopsy by Verhoeff) the post-mortem disclosed pia-arachnoid congestion, with numerous edematous foci of suppuration in the sulci on the side and base of the brain. The cerebro-spinal fluid was turbid. Both cavernous sinuses were distended with pus and their walls lined with thrombi. The circular sinus was filled by a purulent thrombus. The left superior and inferior petrosal sinuses were full of purulent deposits continuous with a thrombus blocking the right jugular vein. The other sinuses were free and the frontal and ethmoidal cells were normal. The sphenoid cells were filled with pus and the surface of the sphenoid bone was covered with purulent exudate. The orbital tissue on the right side was edematous but showed no suppuration. Orbital tissues of the left eye contained pus in direct continuity with that of the left cavernous sinus. Cultures showed only the staphylococcus pyogenes albus. The post-mortem examination revealed a connection between the sphenoidal suppuration and the sinus, a direct infection such as occurs in the lateral sinus from middle ear disease. Sections of the lung demonstrated purulent foci throughout the pulmonary tissues.

A typical case report will perhaps illuminate the subject better than a mere repetition of symptoms. An example of otitic infection is selected because it is not infrequent.

The patient, a boy of seven, has, let us say, had no previous ear trouble until five or six days before coming under observation, when he is taken with severe pain in one ear followed by discharge and mastoid tenderness. There may have been a broncho-pneumonia, the middle ear and mastoid soon sharing in the invasion of the pneumococcus. The otorrhea and the mastoid edema increase, extending, perhaps, anteriorly to the auricle, the swelling finally involving the region of the parotid gland. Slight chills may then be noted, with rapidly rising temperature which in a few days reaches 104° or 105° F. The edema anterior to the auricle has now extended over the zygoma or side of the face, with tenderness along the course of the internal jugular vein. If the case be not seen until this stage is reached the mastoid is promptly opened, the lateral sinus incised and the internal jugular ligated in the neck. In another twenty-four or thirty-six hours the temperature, instead of remitting, continues high and irregular; the pupils are contracted and react sluggishly to light or not at all; the patient is dull and partly comatose; optic neuritis is observed; Babinski's sign is elicited on one side; Kernig's sign present. Often there is slight chemosis of the lids and a suggestion of orbital cellulitis on the same side as the swelling of the face and temple. Occasionally, involuntary movements of the bowels and transient epileptiform attacks follow.



Early Stage of Cavernous Sinus Infection from Otitis Purulenta. Chemosis of lids and exophthalmos marked in both eyes. (Langworthy.)

At this point the *prognosis* is doubtful since we do not know what is taking place within the cranium. The patient soon becomes delirious and tosses about as if in pain. There may now be divergent strabismus, difficulty in swallowing and the (first) appearance of a metastatic abscess in a distant joint. The chemosis of the lids and exophthalmos of the eye on the same side as the mastoid focus rapidly increases. Orbital cellulitis may become very marked, followed by periosteal abscess or even panophthalmitis. In forty-eight hours chemosis of the lids and exophthalmos of the opposite eye is sure to follow. The exophthalmia and lid chemosis may finally be seen to vary, alternate, that is to become more marked in first one eye and then in the other. Death quickly follows from exhaustion, the temperature rising as the end approaches. It is remarkable how long a case so septic will linger, often for several days.

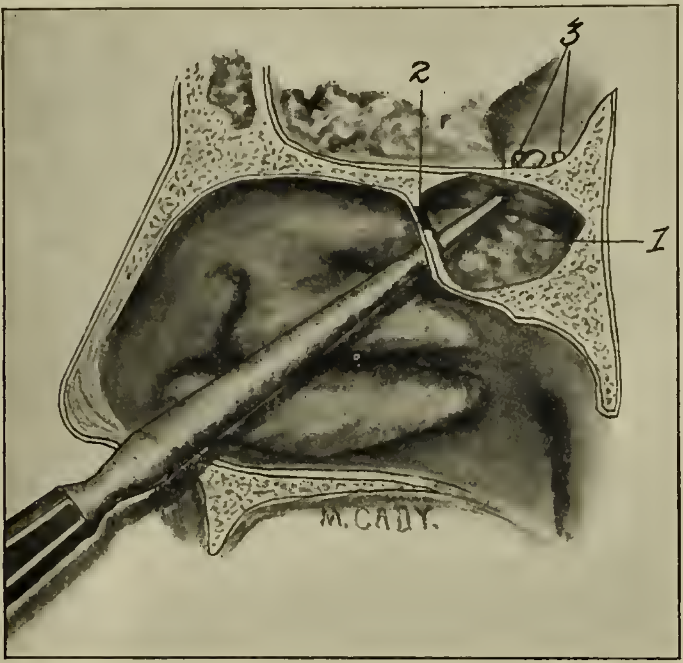
The whole duration of the actual sinus disease is rarely over six or seven days although the writer observed one case in which unmistakable sinus symptoms lasted for twelve days.

To recapitulate; the prominent signs and symptoms of septic cavernous sinus thrombosis occur in this order: pain about the eyes, headache, slight paralysis of a nerve within the sinus, chemosis of the lids, exophthalmos, edema of the face and neck on the same side as the infection, gradual involvement of the second or opposite eye by lid swelling and exophthalmos, pyemia and death.

Differential diagnosis. This condition is to be differentiated from orbital cellulitis, beginning erysipelas and septic infection of the frontal sinus. The diagnosis, when the eye symptoms are associated with a known focus, as for instance a suppurating middle ear, is easy and there can be small chance of a mistake. In the ophthalmic cases, however, where the trouble starts anteriorly and travels backwards, it is difficult to be sure of the diagnosis until the second eye begins to show some involvement. Nevertheless, any case of exophthalmos with marked toxic symptoms should be regarded as suspicious of cavernous sinus infection.

The *prognosis* in thrombosis of the cavernous sinus is bad. At present one has little to offer in the way of effective treatment, or that promises anything like a reasonable chance for recovery. Until we have a better understanding of the very early signs of the disease we cannot expect to improve in either diagnosis or surgical treatment. The difficulty of access to the sinus is also another stumbling block to many who have not made a special study of this subject. It is not, however, the inaccessibility of the sinus which baffles the surgeon so much as the fact that even if the sinus be opened and drained the tissues are so septic by the time the diagnosis is made that there is little hope of recovery. The responsibility of the surgeon is, consequently, great. Even if the relatives or parents are willing to have anything attempted surgically that may offer the remotest chance for recovery many authorities are still inclined to avoid operative measures.

The rational *treatment* of this disease consists in incising and draining the cavernous sinus directly. If the ophthalmologist does not care to attempt this a general surgeon or rhinologist who has made the sphenoid region a particular study should be called in consultation. As the management of these cases is a matter of some difference of opinion, the following consideration of points bearing directly on the subject of treatment may not come amiss.



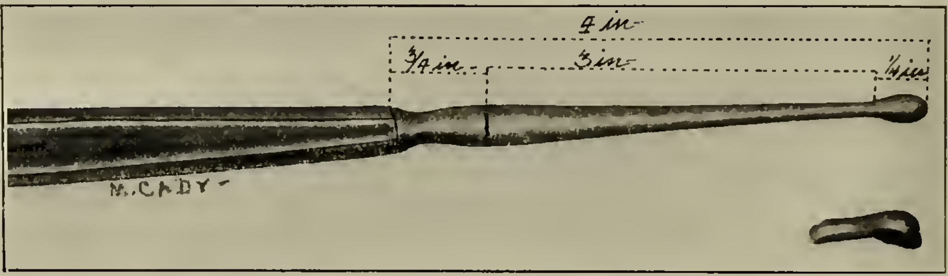
Opening the Cavernous Sinus.

Curette shown introduced into right nares and passed upward through the thin bony anterior wall and the roof of this sphenoid into the cavernous sinus region. The end of the curette is seen to protrude just beyond the roof.

1, Sphenoidal sinus. 2, Orifice of sphenoidal sinus. 3, Circular sinuses lying upon the roof of the sphenoidal sinus with the fossa for the pituitary gland. (Langworthy.)

The study of cavernous sinus thrombosis is limited so far as head surgery is concerned chiefly because, first, cases are rare and the average surgeon will scarcely see, even in a lifetime, more than two or three patients suffering from this disease; second, being surgically less accessible than almost any other structure in the body, few men, when confronted with the condition really consider the sinus available for surgical interference, especially in septic cases. It would seem, however, that if we are to progress in our handling of so baffling a disease we must tenaciously adhere to these cardinal points, viz.: (a) making a reasonably positive diagnosis as early as possible; (b) regarding the sinus just as one would any large vessel in the body which has become thrombosed; (c) opening up that path which would seem to the surgeon in charge best fitted for drainage.

As indicating how little has hitherto been done in devising rational methods of surgical treatment it may be stated that Dwight-Germain's unsuccessful operation on a septic case, a second case reported by H. Knapp of aseptic thrombosis (the result of sarcomatous growth) and a third case by Cushing in which he accidentally injured the cavernous sinus (resulting also in aseptic thrombosis) all followed the so-called Gasserian ganglion routes. These form our principal cases for observation. Luc, of Paris, and the writer have further given the results of cadaver study in an attempt to work out a more practical route to the sinus through the nose.



Curette with Heavy Handle and Long Tapering Shank Used in Opening the Cavernous Sinus.

The overhanging edge of the spoon assures a blunt non-cutting end when introduced into the nose. A mark 3 inches from the neck of the spoon is the distance allowable for a ¼ inch penetration of the sinus. The instrument is weighted not unlike a dagger. (Langworthy.)

The cavernous sinus can be reached in three ways, (a) by a low, osteoplastic resection of bone through the side of the skull following the Gasserian ganglion route; (b) anteriorly, but with great difficulty, through the frontal bone, and, best of all perhaps; (c) upwards, from the nasal cavity through the thin roof of the sphenoidal sinus at the junction of the roof with its external or lateral wall. The writer, after considerable study and slight variations from the original operation proposed a number of years ago, has settled in his own mind at least upon the following plan as being best adapted for general use.

As soon as the diagnosis seems assured a nasal operation should be performed by (a) removing the entire middle turbinal, any obstructing ethmoid cells and the anterior wall of the sphenoidal cavity. The completion of the operation is then in order by (b) forcibly breaking through the sphenoidal roof, at the junction of the roof and lateral wall, into the cavernous sinus with any non-cutting instrument. If thrombotic the sinus will not bleed unduly and, the bony outline of the sphenoidal cavity being retained, there is no reason why proper packing may not be carried out, especially if required in an emergency.

In addition to this intra-nasal method the writer has found the following plan of opening the cavernous sinus to be quite easy on the cadaver, a fact which might make possible its use in cases (perhaps at a late period of the disease) in which the vitality is low:—(a) Introduce a long blunt-end curette with a heavy handle (see the figure) as far as the posterior pharyngeal wall and locate the inferior surface of the body of the sphenoid bone above the naso-pharynx. This can be done by the sense of touch alone. (b) Withdraw the instrument until the curette edge passes just above the junction of the anterior and inferior wall of the sphenoid cavity and force it backward (and of necessity upwards) through the anterior wall and roof directly into the cavernous sinus. The blunt end of the curette will push the yielding wall of the sinus almost half an inch without damage. With the finger at a mark on the shaft three and one-fourth inches from its end, the instrument may be rotated and the overhanging edge of the curette will grasp portions of the bony roof. With this single instrument an opening can be made directly into the sinus from below without the aid of the eye. This operation would scarcely need more than local anesthesia were it applied to an actual case.

Half-hearted attempts to drain the orbit or ophthalmic vein cannot, in the nature of things, be successful. To expect results it would seem that the cavernous sinus must be opened as freely as the aural surgeon opens the lateral sinus and with the same chance for permanent drainage.—(H. G. L.) See, also, **Cavities, Neighboring, Ocular relations of.**

Cavernous sinus, Tumor of the. From time to time observers report neoplasms involving the cavernous sinus in which the eye symptoms vary according to the extent and character of the growths. Nettleship published one of the earlier accounts (*Trans. Oph. Soc. U. K.*, I, p. 186) of a sarcoma that occupied the right sinus and involved the sella turcica. There was atrophy of the third and sixth nerves from pressure, the latter having passed through the tumor mass. Total ophthalmoplegia moderate proptosis and complete ptosis resulted but strange to say, there were no ophthalmoscopic changes, central vision was good and neither the optic nor the fifth nerve was affected.

Cave, Veine. (F.) Vena cava.

Cavità adiacenti all'orbita. (It.) Neighboring cavity.

Cavità orbitaria. (It.) Orbital cavity.

Cavité orbitaire. (F.) Orbital cavity.

Cavité orbitaire des poissons. (F.) Orbital cavity in fishes.

Cavities, Accessory. See **Cavities, Neighboring.**

Cavities, Neighboring, Ocular relations of; Ophthalmic relations of. The relations between the orbit and its contents and the complex system of air cells in the bones of the face, almost completely surrounding the orbit, are of the first importance to the ophthalmologist. Many of the important surgical routes to these cells lie through the orbit and closely involve ocular tissues. Again, many of the earliest symptoms of disease of these sinuses may be detected by the ophthalmologist. Anomalies of the visual fields, the presence of a central or paracentral scotoma, as well as the enlargement of the "blind spot" all play a conspicuous rôle in the detection of sinus diseases. Ordinary asthenopic symptoms may indicate nasal disease, particularly if the headache or visual disturbances be unilateral, or if it is found that the painful eye symptoms are not dependent upon use of the eyes entirely but occur at night or at other times when the eyes are at rest.

The ophthalmologist, therefore, should be qualified to examine the nose as a routine procedure, and in doubtful cases the assistance of a skilled rhinologist should be sought.

The numerous veins, arteries and lymphatics, as well as the nerve supply which the accessory sinuses and the orbit share in common, make possible many signs and symptoms referable to these sinuses. To enumerate a few will serve to illustrate. These symptoms vary in intensity from a slight lacrimation with injected conjunctival vessels to swollen lids, proptosis or immobile or deviated globe or abscess or cellulitis of the orbital tissues. Optic nerve involvement is very frequent and varies in degree from edema with pressure on the nerve fibres, as shown by a small central scotoma, to severe optic neuritis or thrombophlebitis with retinal hemorrhages followed later on by atrophy of the nerve.

The location of pain is unfortunately not pathognomonic of disease in any sinus although there is much information to be gained by searching for areas over the sinus walls tender to pressure.

In doubtful eye cases, where the etiologic factor is not readily determined, routine examination of the sinuses is invaluable.

Eversbusch (Die Erkrankungen des Auges in ihren Beziehungen zu Erkrankungen der Nase und deren Nebenhöhlen, sowie zu Erkrankungen des Gehörorganes, Graefe-Saemisch *Handbuch der Ges. Augenheilk.*, 1903) has made a very exhaustive research of the literature dealing with the intimate relations between nose and eye, in which he gives credit to those pioneers in this field, Berger-Tyrmann, Germann, Hajek, Kuhnt, Vossius, Winckler and Ziem. A very good clinical classification of those diseases of the nasal sinuses which affect the eye is that given by Mackay *(Lancet,* Aug. 1908). There are four groups: First, mucoceles of the sinuses; second, acute or chronic sinusitis with external signs of orbital cellulitis, orbital abscess, tumor growth, edema of the eyelids or apparent dacryocystitis; third, sinusitis without external signs of orbital inflammation, but with ophthalmoscopic signs such as optic neuritis, neuroretinitis, retinal thrombosis or phlebitis, or without ophthalmoscopic signs but with visual disturbances such as central scotoma, visual field defects, ocular muscle paralyses or fifth nerve disturbances; fourth, cases in which the association of sinus disease has been asserted but which Mackay considers questionable, such as glaucoma, iritis, uveitis, keratitis and lens and vitreous opacities. Another class which is very important to the ophthalmologist has been omitted, namely the unilateral headaches and asthenopic symptoms due to rarefaction of the air within the frontal sinus and anterior ethmoidal cells. This type of headache was first described by Ewing and Sluder (Frontal Headaches, Apparently Ocular but Really of Nasal Origin, *Trans. Amer. Ophthal. Soc.*, May 2, 1900) and independently by Robertson (*Jour. A. M. A.*, Mar. 5, 1904) and the writer (Brawley, Entrance Thesis, *Chicago Oph. Soc.* 1905 and *Trans. Oph. Sec. Amer. Med. Ass'n.*, 1906). The pain is unilateral, although if severe it may become general later in the attack. Stooping increases the pain and slight vertigo frequently is noted upon assuming the erect position. Lacrimation, edema of the upper eyelid and injection of the conjunctival vessels have frequently been noted in this condition. During the attack the patient is unable to read without aggravating the symptoms, and complains of blurred vision, although during the intervals between the attacks the eyes may be used for near work with perfect comfort. The attacks seem to be brought on by an acute coryza, the menstrual period or damp, chilly weather. There is usually tenderness to pressure against the floor of the frontal sinus, especially in the region of the pulley of the superior oblique muscle, and against the inner wall of the orbit, the os planum of the ethmoid. This symptom is not constant, but may often be elicited by producing pressure on corresponding points in both orbits simultaneously when greater tenderness will be felt on the affected side. The nasal examination may be negative even when made by a competent rhinologist, but if the patient is seen during the attack the middle turbinal will usually appear turgescent or will be found closely applied to the lateral nasal wall, blocking the hiatus semilunaris. The attack may then be modified or entirely relieved by the application of cocain and suprarenalin to the middle turbinal and infundibulum. When such a case is observed between attacks it is often possible to produce the symptoms by applying the author's suction pump, subsequently relieving the congestion thus produced by the use of cocain and suprarenalin. Then, having proved the diagnosis the relief may be made permanent by resecting sufficient of the middle turbinal to uncover the lower end of the frontonasal duct and hiatus. Sluder (Frontal Headaches, Apparently Ocular, *Trans. Amer. Ophthal. Soc.*, 1900) has occasionally found it necessary to remove the greater part of the uncinate process of the ethmoid where the hiatus was very narrow.

Symptomatology. From the standpoint of the ophthalmologist the eye symptoms referable to nasal disease are most important.

Asthenopia. It is probable that asthenopia due to nasal disease is chiefly of a reflex nature, as the nerve supply is derived from a common source, the fifth nerve furnishing the sensory roots for the motor cranial nerves. The nasal nerve, which is a branch of the fifth cranial, enters the orbit through the sphenoidal fissure and passes over to the nasal wall. In the orbit it gives off the two long ciliary branches to the eyeball, the long root of the lenticular ganglion, and the infratrochlear nerve which supplies the region of the inner canthus, the lacrimal sac and caruncle. Leaving the orbit through the anterior ethmoidal foramen it passes upward and forward between the dura and the cribriform plate to the ethmoid fissure where it enters the nasal cavity again, giving off branches to the anterior part of the septum, the anterior portion of the middle and inferior turbinate bodies and the mucous membrane of the lateral nasal wall. It then continues as the anterior or terminal branch supplying the sides and tip of the nose.

Photophobia and lacrimation may be due to the conjunctival congestion occurring during a sinusitis or to involvement of the ocular muscles including the ciliary. Kyle (*Jour. Am. Med. Ass'n.*, Sept. 25, 1909) calls attention to an eye symptom which he frequently finds in sinus disease, namely pain in the corresponding eye noted upon looking up while trying to read. Risley (Risley, Sr., *Penn. Med. Jour.*, June, 1904) reports a case of persistent eye discomfort with photophobia and congested fundi which was relieved by the application of cocain to the swollen middle turbinate bodies. Permanent relief was subsequently obtained by cauterization of the turbinals.

Ziegler (*N. Y. Med. Jour.,* Nov. 7, 1908) gives as the three chief nasal sources of reflex ocular symptoms, pressure contact, hyperesthesia and nasal obstruction. In the first case the middle turbinal may produce pressure against the septum which at this point is most sensitive and may even produce a turgescent hyperesthetic area on the septum. This contact may cause muscular twitchings or choreiform movements of the face, head and neck and also severe headache. A sharp septal spur may produce the same effect by pressing into one or the other turbinate body. Synechiæ act similarly. Ziegler calls the septal area opposite the anterior third of the middle turbinate body the "eye spot of the nose" as it is a frequent source of the ocular reflex symptoms, such as supraorbital neuralgia, lacrimation, congestion of the conjunctiva with burning and smarting of the lids, blepharitis, etc. Irritation at this spot will produce frequently the same symptoms which the patient experiences during his attacks. Where middle turbinals impede respiration and prevent air from reaching the superior meatus in the so-called attic of the nose, these various reflex eye symptoms may be called forth. The "Sunday morning headache" in his opinion is due to prolonged pressure—contact between the middle turbinals and the septum from sleeping unusually late.

In a series of cases published by Hoople (*Medical News,* April 13, 1901) asthenopic symptoms and muscular imbalance were present and were found to be due to pressure of the middle turbinal against the septum as shown by a return to normal following removal of that portion of the turbinal producing the pressure. Hoople (*Brooklyn Med. Jour.,* Oct. and Nov., 1900) has also reported an extreme case of a nasal reflex neurosis with the following symptoms: pain and throbbing at the inner canthus of one eye and along the side of the nose with frequent conjunctival congestion, lacrimation and blurring of vision, pain below one ear near a swelling in that region of the middle cervical ganglion, recurring severe vertical headaches, pain on ocular excursion. Relief was obtained by removing part of each middle turbinal and of one inferior turbinal and cauterization of the sensitive areas on the septum opposite.

The headache of nasal disease very closely resembles that due to refractive and muscular anomalies of the eyes, and consequently the oculist sees these cases frequently in the earliest stages. Snydacker's (Zur Differentialdiagnose Zwischen Okularen Kopfschmerzen und Solchen verursacht von Nebenhöhlenentzündungen, *Klinische Monats-*

blätter f. Augenheil., June 1909, S. 629) statistics show that in seven to ten per cent. of the patients who consult an ophthalmologist on account of headaches, the cause is to be found in disease of the accessory sinuses of the nose.

The location of the headaches is not characteristic of disease of a particular sinus, although in general the pain of a frontal sinusitis, for instance, is located over the area occupied by that sinus. Sinus headache may occur during the night, an unusual time for the occurrence of ocular headache, except when due to a definite inflammation such as an iritis. It is possible for confusion to arise in seeking the source of headache and asthenopic symptoms, especially muscular asthenopia, where the degree of the refractive error and the muscular anomalies are sufficient in themselves to account for all symptoms. The diagnosis becomes increasingly difficult where no nasal symptoms are complained of and the nasal origin may be detected only by repeated examinations of the nose and accessory sinuses. Sinus headache is frequently paroxysmal in character, occurring at a regular hour, usually in the morning and ending at a corresponding time each day. Frontal sinus headache is usually noted in the frontal region, although reflex pain may occur in the occipital region, frequently occupying a circumscribed area. Ethmoidal pain is most frequently felt at the root of the nose or behind the eye and may be exaggerated by ocular excursions. The pain of antrum disease is often referred to the teeth of the corresponding upper jaw or backward to the ear or side of the head and is markedly increased by stooping. This symptom of increase in the headache accompanied by a sensation of pressure upon stooping is very characteristic of the more acute forms of sinus disease. Sphenoidal disease is productive of occipital and temporal headache or pain at the "base of the brain" and back of the eyes. Cases of chronic sinus disease are frequently entirely free from pain, although upon palpation, tenderness of the sinus walls may be elicited.

Disturbances of the visual fields. The most frequent change found in the field of vision is the unilateral central scotoma for colors and in a more advanced stage for white as well. In some instances a distinct retrobulbar neuritis occurs with blurred central vision gradually extending to the rest of the field and producing partial or complete blindness. In the early stages no fundus changes are to be seen, but later the margins of the disc become hazy, or papilledema or a distinct optic neuritis may be found. Ziem (*Berlin Klin. Wochenschr.* 1889, No. 38 and 39) has reported seven cases with narrowed visual fields which were improved by nasal treatment. In six venous stasis could be made out at the disc and in one case a well developed optic neuritis was found. In the latter case douching the nasal cavities to remove the accumulation of pus produced rapid improvement. The maxillary sinus proved to be the source of the pus and after proper drainage was established the visual field steadily improved. No further reference was made in the report to the course of the optic neuritis. Ziem (*München. Medicin. Wochenschr.* 1892, No. 16. S. 267) a few years later reported a case where an extensive tumor mass, which was probably a sarcoma, partially filled the nares and naso-pharynx on both sides. The submaxillary and cervical lymph glands were involved and the case ended fatally. The astonishing feature was the improvement in the visual field from less than 5° to 25° nasally and 55° temporally after eight days of irrigation of the nares which brought forth a large quantity of thick, fetid discharge.

When the very close relation between the canal of the optic nerve and the sphenoidal sinus and posterior ethmoidal cells is considered, the optic nerve disturbances are easily understood. In some cases the process is undoubtedly a toxemia and the highly organized optic nerve fibers to the fovea are the first to suffer, which explains the frequency of central scotoma. Later, narrowing of the visual fields may also occur as the toxic process further involves the optic nerve. Risley (Ocular Affections Associated with Disease of Sinuses, etc., *Annals of Ophthalmology,* Oct. 1908, p. 608) reports a case of optic neuritis with impaired central vision, contracted fields and flame-shaped hemorrhages in the nerve-head and throughout the fundus. No scotomata were found. After observing the case for two years with no improvement the nose was examined and obstruction due to hypertrophy of the middle turbinal and polypoid masses was found. These were removed and creamy white pus drained from the frontal sinus and ethmoidal cells with relief of all the symptoms and vision and visual fields returned to normal. Risley (*Journal of Nervous and Mental Diseases,* May 1909) also quoted a case of double optic neuritis in which there was reduction of visual fields to 40° which was cured and the fields restored to normal by draining the frontal and ethmoidal cells. As long ago as 1886 Ziem (*Monatsschr. f. Ohrenheilkunde* u. s. w. 1886, No. 2 u. 4, S. 137) had observed that disease of the sphenoidal sinus produced constriction of the visual fields much more frequently than maxillary sinus disease. Killian (*Monatsschr. f. Ohrenheilkunde* u. s. w., 1887, No. 10 u. 11, p. 322) a year later came to the same conclusion. Both quoted cases showing gradual improvement following drainage of the affected sinus, not only in the visual fields, but marked improvement in the central vision.

That it is possible for both optic nerves to be involved where one sphenoidal sinus is infected may be shown anatomically, one of the author's specimens showing a small sphenoidal sinus on one side and a very large sinus on the other overlapping the posterior wall of the first. A very interesting case which may have been of this type was reported recently by de Schweinitz. (Some Observations of the Ocular Manifestations of Sinus Disease. *Trans. Amer. Ophthal. Soc.,* 1910). This patient had suffered many attacks of fugacious episcleral congestion with severe headache and complained of failing vision. Examination revealed a small central ring scotoma in the left field and a triangular paracentral scotoma in the right. After repeated examinations some pus was removed from the left sphenoidal sinus. Irrigations of this cell and general eliminative treatment brought about a gradual improvement in vision and in the visual fields. At the different stages of the process small triagular hemianopic scotomata were found, followed by small central scotomata, later becoming oval and resembling the scotomata of toxic amblyopia. The presence of the hemianopic scotomata was thought to be due to a possible tumor of the optic chiasm or a localized patch of meningitis in this area. The vision rose to 6/25 however, and ordinary print could be read by tilting the book on one side. There was never any positive alteration in the optic disc, but during the periods of episcleral congestion the corneal epithelium showed a decidedly curious wrinkling. Birch-Hirschfeld (Die Beziehungen der Entzündlichen Orbitalerkrankungen zu den Erkrankungen der Nebenhöhlen der Nase. *Klin. Monats. f. Augenheil.* Jan. 1908, p. 1) has noted changes in the visual fields in accessory sinus infections and quotes Grünwald, Kuhnt, Ziem and Germann as having also observed such changes. Grünwald considers them to be due to a psychic asthenopia, Ziem to a passive hyperemia of the ophthalmic veins and Kuhnt believes that the source is to be found in the absorption of toxins from the infected sinus. That the visual field is not invariably affected is attested by Haeffner and Henrici quoted by Birch-Hirschfeld, who found no disturbance of the fields in seventeen ethmoidal and three sphenoidal sinus infections. There is no doubt that these visual field disturbances would be found in a much larger percentage if carefully searched for, especially the central scotomata for colors. The latter are so easily and quickly determined that this test should become part of a routine eye examination, especially where any visual disturbance is complained of. Rhinologists might aid in the study of this subject by applying the test to all cases of accessory sinus infection. All that is required to make the test is a white card having upon it a red and a black dot 2 mm. in diameter and about 2 cm. apart. If the color of the red dot is more pronounced while the eye fixes the black dot than while looking directly at the red dot, or if the red color fades entirely while looking directly at the red dot, a central scotoma for red is present. This may later be carefully outlined with a perimeter.

In five per cent. of eighty-three cases reported a few years ago by Birch-Hirschfeld (Die Beziehungen der Entzündlichen Orbitalerkrankungen zu den Erkrankungen der Nebenhöhlen der Nase. *Klin. Monats. f. Augenheil.*, Jan. 1908, p. 1.) with orbital involvement secondary to ethmoidal disease changes were found in the visual fields. He also refers to eight cases, one of which occurred in his own practice, where the finding of an absolute central scotoma aided in the diagnosis of a sphenoidal sinus infection. Three cases of sphenoidal disease with a small central scotoma for red, some orbital pain and supraorbital neuralgia were observed by Birch-Hirschfeld which were relieved by drainage of the sphenoidal sinus.

It is not always possible to make a differential diagnosis in these cases, but in general they are unilateral as against the bilateral scotomata of general toxemias, such as alcohol-tobacco amblyopia, and are also of much more sudden inception, more rapid in their course and are accompanied by pain.

A very marked case of optic nerve involvement from empyema of a sphenoidal sinus was lately reported by Holmes (Head Pains and Eye Symptoms Caused by Inflammation of the Accessory Sinuses of the Nose. *Ohio State Med. Jour.*, Feb. 1906), in which the field of vision was normal, although the vision was much impaired and a haze covered all objects. Eight days later there was complete blindness, with a fixed, dilated pupil, with no definite symptoms of an accessory sinus infection. Holmes, by exclusion, diagnosed empyema of the sphenoidal sinus and at operation found pus in the sinus under pressure. Following the operation there was relief from the headache and eleven days afterward vision began to return in a portion of the field. Twenty-two days after the operation the limits of the field were normal, only a small central scotoma remaining.

Eyelids and conjunctiva. Edema usually involving the upper lid occurs as the result of disease of the frontal sinus and anterior ethmoidal cells particularly, and is due to venous stasis. This form of edema is usually greater in the morning and lessens as drainage from the sinus takes place. It is to be distinguished from the tense infiltration of the lids, with dusky red discoloration of the skin, which is seen in orbital cellulitis or abscess and which is usually accompanied by edema of the bulbar conjunctiva, proptosis and hyperpyrexia. The so-called "fugitive edema" of the eyelids which has long been recognized as accompanying periodic headaches is probably due in many instances to unsuspected sinus disease. This opinion is maintained by de Schweinitz (Some Observations of the Ocular Manifestations of Sinus Disease. *Trans. Amer. Ophthal. Soc.* 1910, p. 480), who quotes an instance reported by Dunn (A Case of Recurrent Edema of the Upper Eyelid as a Symptom of Nasal Polypus. *Amer. Jour. of Ophthal.* 1892, p. 134), where a recurrent edema of the upper eyelid was relieved by removal of a myxomatous middle turbinal with polypi. No reference was made by Dunn to a possible sinus condition, but de Schweinitz believes that the operative measures probably served to provide drainage for unsuspected disease of one or more sinuses. Edema of the upper eyelid is considered by Gerber (Die Complicationen der Stirnhöhlenentzundungen, 1909, S. 207), as one of the earliest symptoms of orbital involvement. He also mentions the rare condition where the eyelids are lengthened by the stretching of a long-standing exophthalmus.

Circumscribed orbital edema from frontal sinusitis. Posey (*Annals of Ophthal.* April, 1912, pp. 274) reports a case of circumscribed edema of the orbit which proved to be due to suppuration of the corresponding frontal sinus. The eye was proptosed and a smooth swelling was found under the supraorbital rim, with swelling of the upper lid, but normal conjunctiva. The upper and outer excursions of the globe were limited, the pupil larger than that of the fellow eye and the vision was 5/7½. There was a history of nasal disease but no other evidence of a possible cause.

Wood, of Howard Hospital, Philadelphia, made the rhinologic examination. He found mucopurulent secretion draining from under the anterior end of the middle terminal. The frontal sinus was irrigated with negative results. The swelling did not subside and was incised, yielding a few drops of pus. Healing was prompt. There was apparent enlargement of the blind spot but as it was equal in both eyes it was not considered significant. Posey believes that an inflammatory edema occurred secondary to infection of the frontal sinus.

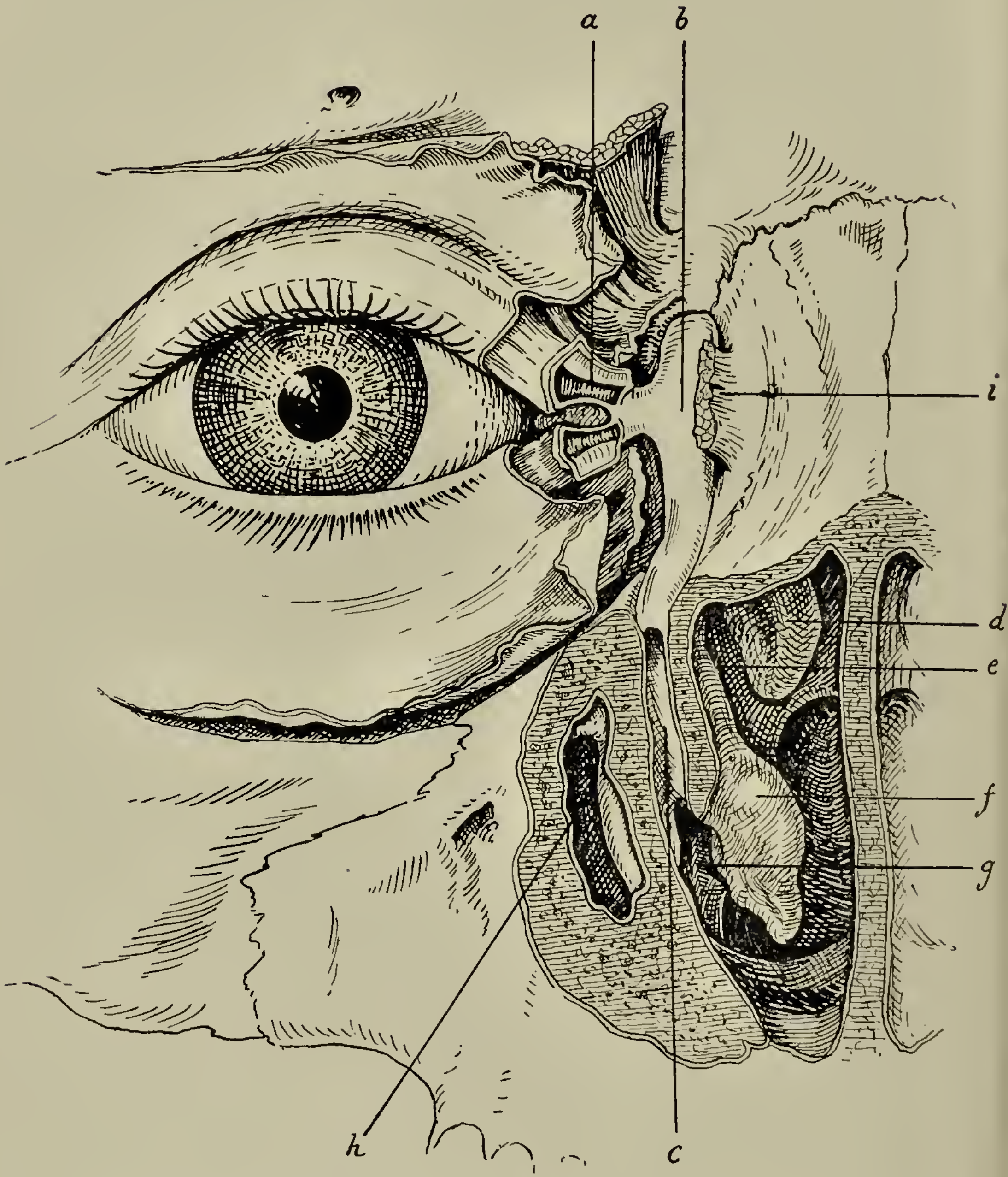
Ziem (*Monatsschr. f. Ohrenheil.* u. s. w., Aug. 1893, S. 231) has even attempted to show a relation between nasal infection and trachoma which in the light of the discovery of possibly specific trachoma bodies by Prowazek, Greef, Frosch and Halberstädter is improbable.

Ptosis may occur as a result of extension of an inflammatory process from the posterior ethmoidal cells or the sphenoidal sinus to the apex of the orbit. A chronic conjunctivitis or marginal blepharitis may result from the chronic congestion accompanying disease of the sinuses or by infection from the nasal secretions via the lacrimo-nasal duct.

Laurens (Affections Nasales et Troubles Oculairies Reflexes. *Annal. d' Oculistique*, April 1896, p. 241) has reported a case of blepharospasm which was entirely relieved by the removal of synechiæ from the nose, together with hypertrophied turbinals.

Lacrimal apparatus. Disease of the lacrimal apparatus has long been recognized as secondary to nasal disease in the majority of instances. The connection is so direct that such an inference is obvious. The most frequently recognized nasal condition to cause lacrimal disease is the obstruction of the lacrimo-nasal duct by hypertrophy or malposition of the inferior turbinal. Serious disturbance of the lacrimal canal, such as periostitis or necrosis with resultant obstruction, is, however, more frequently due to ethmoidal or antral disease, from their close relation anatomically. Fistula from the frontal sinus or from an anterior ethmoidal cell may occur in the region of the lacrimal sac, producing a perisaccular abscess and simulating blenorrhea of the sac, and such an abscess has been known to perforate into the lacrimal sac, further complicating the diagnosis. Epiphora is present in practically all cases of involvement of the ocular apparatus from sinus disease. It is often one of the earliest symptoms and when noted indicates the necessity for a careful nasal examination. Turner (*Edinborough Med. Jour.*, May 1909) observed epiphora for two years in a case of chronic accessory sinus disease before other eye symptoms were noted and he lays great stress upon the importance of this symptom in making an early diagnosis. Ziem (*Monatsschr. f. Ohrenheil.* u. s. w., Aug. 1893, S. 231) in discussing the history of this subject of ocular and nasal relations refers to the observations of G. A. Richter in the eighteenth century, showing that even at that time fistula of the lacrimal sac was recognized as being due to nasal infections, especially where polypi were present. Formerly, in many eye diseases, notably those of the lacrimal sac, withdrawal of blood from the nose by means of leeches or scarification of the turbinals was recommended. Ziem quotes a number of instances tending to show that nasal infections are responsible for lacrimal sac disease and other eye diseases as well, such as phlyctenular keratitis, conjunctivitis, disease of the uveal tract, etc.

Cornea and sclera. The cornea is seldom directly affected by dis-



Relations of the Eyeball to the Lachrymal Apparatus and the Nose.

a. Lachrymal canaliculus. b. Lachrymal sac. c. Lachrymo-nasal duct. d. Middle turbinate bone. e. Middle meatus of nose. f. Inferior turbinate bone. g. Inferior meatus of nose. h. Antrum of Highmore. i. Tendo oculi.

case of the nasal cavities. Keratitis and corneal ulceration may occur secondary to disease of the lacrimal sac, from a panophthalmitis following orbital abscess, or from exposure in extreme proptosis of the eyeball. A herpetic eruption of the cornea has been described by Posey (Some Ophthalmological Phases of Diseases of the Accessory Sinuses of the Nose. *Jour. Eye, Ear and Throat Diseases.* Mar.-Apr. 1905, p. 31.) and is referred to by Gerber (Die Complicationen Stirnhöhlenentzündungen 1909). Posey considers this complication to be due to involvement of the fifth nerve where it passes along the outer wall of the sphenoidal sinus. Edema of the corneal epithelium producing a peculiar wrinkled effect resembling the appearance produced upon the cornea by an excess of cocain, has been noted by de Schweinitz (Some Observations of the Ocular Manifestations of Sinus Diseases. *Trans. Amer. Ophthal. Soc.* 1910, p. 483) in the more violent types of episcleritis due to sinus disease. The sclera is rarely affected by disease of the accessory sinuses, although injection of the vessels of the bulbar conjunctiva has frequently been noted in frontal sinusitis and the anterior perforating vessels of the sclera may become tortuous. A type of episcleritis, however, has recently been described by de Schweinitz (Some Observations of the Ocular Manifestations of Sinus Disease. *Trans. Amer. Ophthal. Soc.* 1910.), under the name of fugitive episcleral congestion. There is a deep-seated subconjunctival injection of the blood vessels and the tissues underneath them have a violaceous tint. The congested area is not bleached by adrenalin and in most instances is confined to the outer half of the globe. The congestion is periodic and is always associated with violent headache. Hyperemia of the iris with great resistance to the action of a mydriatic was observed by de Schweinitz in one case of this type of episcleritis which promptly disappeared after treatment of a sinusitis.

[If the Editor of this *Encyclopedia* may express an opinion on some important symptoms common to or produced by affections of the nose and accessory cavities it is that the differential diagnosis between *headache* due entirely to neighboring cavity affections and that due to eye diseases alone has not been clearly established. Glasses have been prescribed and other eye treatment given for the relief of a frontal headache subsequently shown to be due to ethmoidal disease or infection of the frontal or other accessory sinus. *Per contra,* it is not infrequently observed that only after making the devious nasal passage straight or after resorting in vain to other remedial measures does the rhinologist suspect that his patient's uncured headache may be due to eye-strain. While evident defects in the ocular refraction or a decided lack of balance in the eye muscles (or both together), or the presence of a painful disease of either eye may properly give rise to suspicion that the diseased organ is responsible for the headache, it must be remembered that the character, site and other peculiarities of the head pains greatly assist in a diagnosis and help us to a conclusion as to their true character. In other words, while the actual alterations in the tissues and abnormality of function must ever be the chief guides in the differential diagnosis of neighboring sinus and ocular headache, the *clinical evidence* is of extreme value and must not be neglected. This is all the more true because in reflex headache the underlying nervous state is of just as much importance as the gross pathological changes in producing these symptoms. Inasmuch as the proportion of ideally perfect nasal cavities or perfectly normal eyes is small, in the presence of headache one cannot always judge from the local conditions alone whether he is dealing with a patient in whom an unstable nervous system is reacting to an otherwise insignificant irritant in the form of a slight nasal or ocular defect, or whether the head ache arises from quite another cause. The following clinical picture of the usual form of ocular headache will serve to emphasize this point:

Ocular headache from eye-strain is almost invariably bilateral; it is rarely severe or accompanied by nausea or vomiting, and it is practically always a daylight headache. It does not keep the patient awake at night, because when the lights are turned out there is no use made of the eyes. There is no eye-strain and consequently no reflex pains. *Head pains from eye defects are almost invariably frontal, temporal or occipito-frontal.* Vertical or general headache or pains confined to one side of the head or to the occipito-nuchal region alone, or very severe acute pain in any part of the head, is probably not of ocular origin.

True eye headache generally follows or is, at least, associated with other eye signs and symptoms. There is a hyperopic astigmatism or some other irritating form of refractive error, some anomaly of accommodation or some marked extrinsic muscular imbalance. Headaches from eye-strain generally follow prolonged and continuous use of the eyes for near work, such as reading, sewing, writing, china-painting, etc.

Much use of the eyes in the distance brings about a similar result. An ocular headache is often the aftermath of a shopping excursion, a railway journey or a visit to the theater. Headache from eye-strain is often accompanied by pain in the eyes themselves, redness of the ocular and palpebral conjunctivæ, blepharitis, catarrhal discharge and other evident signs of ocular involvement.

It must not be assumed from the foregoing that ocular pains and headaches are always due entirely to the eye defects or entirely to diseases of the nasal and accessory cavities. On the contrary, it should ever be borne in mind that the headache primarily set up by an uncorrected astigmatism may be aggravated or precipitated by a nasal "cold" or by the nervous irritation of an infected sinus. In other words, there is such a condition as a mixed, naso-ocular headache.

Vertigo. That dizziness may be set up both by affections of the accessory sinuses and by ocular defects is a fact frequently referred to by authors, but the differential diagnosis of this symptom has been insufficiently discussed. The diseases of the ocular apparatus generally responsible for it are the heterophorias and heterotropias of a paretic character. The vertigo that so often results from paralysis or paresis of the extraocular muscles requires little knowledge and, at most, a superficial examination to determine its exact nature. On the other hand, the etiology of that troublesome, if temporary, dizziness accompanying the ocular imbalance that wavers between a heterophoria and a heterotropia is less readily referred to its proper origin and may easily be regarded as a nasal reflex or attributed to other causes.

Because of this difficulty in diagnosis it may be well to draw a clinical picture of ocular vertigo. Ocular vertigo rarely if ever occurs unless both eyes are used (or an attempt is made to use them) at the same time. Patients are sometimes conscious of this, and in crowded thoroughfares, or when compelled to use their eyes for some time in steady fixation, or are suddenly called upon to see distinctly, close one eye. This generally relieves or prevents vertigo and the diplopia that so often accompanies it.

The fact that double vision is very often of so evanescent a character as to be barely recognizable as such by the patient, is a common co-reflex of vertigo, and is made use of in establishing its ocular character. A rough though effective test and one readily applied by the rhinologist is that with the *red glass.* The patient sits in a semi-darkened room, squarely facing a candle light from ten to twenty feet away. Cover one eye and place over the other a piece of dark red glass, thus directing his attention to the sort of image he should see with the uncovered eye through the tinted glass. The red image, of course, corresponds to the eye over which the tinted glass is placed; the ordinary candle flame to the other eye. Now uncover the second eye; if his eye-muscle balance is good he should see a single pink light —an image composed of the red rays of one eye and the clear light of the other eye. If there is a marked tendency to diplopia he will see two lights—one red, one white—and their distance apart, relative position, tendency to approach or to further separate, etc., will give a fairly accurate notion of their degree and other characters. If there be no tendency in the two images to separate, and the single pink light continues to be seen for several minutes, the patient's vertigo is probably not due to oculo-muscular defects.

An aid to the diagnosis of ocular vertigo is the history of other eye symptoms. Frequently such patients complain of blurring of print in reading or that the letters and lines run together and get mixed up—experiences that are probably a sort of transient diplopia at the near point. They are also prone to complain of "panorama" headache (brought on by shopping, railroad journeys, attendance at theaters and the like), of car-sickness and of photophobia. They are often relieved by the correction of an irritating hypermetropia or an astigmatism. If so, the remedy acts by relieving the associated muscular defect upon which the vertigo throws some light as to its origin, although it does not often distinguish ocular vertigo from other forms of these symptoms.

The words "confusion" and "uncertainty" describe many examples of dizziness arising from oculo-muscular anomalies. The vertigo is rarely so marked that the patient staggers or falls. Moreover, vertigo from ocular defects is plainly the result of attempting to use the eyes. It almost never comes on while the patient lies in bed or is sitting quietly; he usually experiences it while walking in a crowded street or doing something associated with movement of objects or while rotating the eye-balls and at the same time using his accommodation.

Lacrimation. Probably an increased flow of tears is more often a sign of nasal than ophthalmic infection, or, to put it more concisely, the ocular irritation that results in the overproduction of tears or their insufficient drainage, or both, quite commonly originates in nasal disease. This is true even of those cases where organic changes are present in the lids, about the puncta lachrymalia, canaliculi, tear sac or nasal duct. In all instances of chronic lacrimitis especially, the nasal passages should be carefully inspected and any abnormalities likely to damage the lacrimal apparatus should be treated.

Of organic lesions resulting from nasal and accessory sinus disease it is impossible to speak in full detail. It has, however, been well established that, apart from orbital abscess and their optic atrophy due to spread of infection from the ethmoidal cells or to bursting of an abscess originating in the frontal or maxillary sinus, numerous diseases of the eyelids, conjunctivæ, oculo-lacrimal apparatus, cornea, orbital muscles, and even of the choroid have been produced by nasal disorders.

Diseases of the lids are not only associated with affections of the nose and neighboring cavities, but they are sometimes directly the result of the sinusitis. A unilateral edema of the lids—most marked in the morning and aggravated by acute exacerbations of the chronic sinusitis upon which it depends—constitutes a very obstinate symptom until its true character is recognized and the cause removed. This nasal form of blepharitis often appears as a part of conjunctival folliculitis which persists unless the sinus implication is recognized and properly treated.

Perhaps the most interesting of all the ophthalmic sequels of accessory sinus infections and affections are pareses and paralyses of the extraocular muscles. About the occurrence of these there can be no doubt. The ophthalmologist should hesitate to label either of them ''rheumatic'' or ''syphilitic'' or ''idiopathic'' until he is assured that his patient is not a sufferer from sphenoidal or ethmoidal diseases and that either of these affections, if present, has been adequately treated. The immediate cause of ocular pareses in nasal cases is probably a peripheral infection of the nerve filaments supplied to the muscles involved. This infection may take place both in purulent and simple catarrhal infections of the contiguous cavities.—(Ed.)]

Ocular muscles. Disturbance of the balance of the extraocular muscles may occur from extension of an inflammatory process in an accessory sinus. This may directly involve the muscles themselves as in insufficiency of the internal recti or by involvement of the nerves which supply the muscles, as they pass along the outer wall of the sphenoidal sinus. The muscle most frequently affected is the external rectus due to the anatomical position of the sixth nerve supplying it. This nerve passes into the orbit in a groove in the sphenoidal sinus wall, and is likely to be involved in inflammation of the sinus when the sphenoidal wall is thin. A definite diplopia does not occur so frequently as an insufficiency of one or more muscles which may be detected only in the outer portion of the field of fixation by means of the red glass test. Pain may often be elicited in these cases by rotating the eye toward the affected muscle. The imbalance resulting may cause confusion in performing the visual act, vertigo and nausea, and make near work impossible as the ciliary muscle may be likewise affected. Posey (The Ocular Symptoms of Affections of the Accessory Sinuses of the Nose. *Trans. Sec. Ophthal. A. M. A.*, 1905) refers to a case of transient palsy affecting a portion of the third nerve which was accompanied by severe pain in the eye and temple, and in which a spectrum was seen. This case closely simulated that rare condition known as ophthalmoplegic migraine, but was shown to be due to disease of the ethmoidal and sphenoidal cells. He also believes that many cases formerly considered to be rheumatic in origin if carefully studied would reveal underlying sinus disease.

An instance of a complete paralysis of the extraocular muscles has been reported by Holmes. (Head Pains and Eye Symptoms Caused by Inflammation of the Accessory Sinuses of the Nose. *Ohio State Med. Jour.*, Feb. 1906). This patient gave a history of dizziness and disturbed vision of ten days' duration. Ptosis of the upper lid appeared on the fourth day of the attack. Severe pain in the head confined the patient to her bed for six days. Complete paralysis of all the extraocular muscles was present with complete ptosis. The pupil reacted sluggishly and there was slight haziness of the disc margin with contraction of the color fields. Holmes drained the frontal sinus, antrum and ethmoidal cells intranasally and obtained a free flow of pus. Slight motion of the globe was noted five days after operation and improvement continued steadily. As the muscular action and vision were still below normal several weeks after the preliminary operation Holmes stated that a radical operation upon all of the sinuses of the corresponding side would probably be necessary before a complete cure could be expected.

Ziem (*Monatsschr. f. Ohrenheil,* u. s. w., Aug. 1893, S. 231) has produced strabismus experimentally in animals by obstructing one side of the nose, thus producing a symmetrical development of the orbit and ethmoid cells. He also reports cases of convergent strabismus, two of which were his own, which were cured by the removal of turbinal hypertrophies, septal deflections and drainage of the maxillary sinus.

Intraocular disease. Probably the earliest report of visual disturbances resulting from infections of the nasal accessory sinuses is that of Welge (quoted by Ziem. *Monatsschr. f. Ohrenheil,* u. s. w., Aug. 1893, S. 231).

Many cases of iritis which in the past have been considered to be due to rheumatism, intestinal auto-intoxication or of idiopathic origin, are undoubtedly due to nasal disease. The author observed one case in particular which, from a careful urinalysis, seemed to be due to auto-intoxication. The nose was examined and found negative. After several days of thorough eliminative treatment with no effect upon the iritis the nose was again examined and pus was withdrawn from the anterior ethmoidal cells with the suction apparatus, with the result that all signs of the inflammation disappeared within thirty-six hours.

Krauss (*Archiv. f. Laryng. u. Rhin.* Bd. xiii, Heft 1, p. 30) reports two cases of iritis following a radical Killian frontal sinus operation. The iritis was of four days' duration and was considered to be due to extensive removal of the orbital roof. Killian then made the use of atropin as a prophylactic a routine procedure where the radical operation was indicated.

The micro-organisms most frequently found in accessory sinus infections, severe enough to produce ocular complications are—streptococcus, pneumococcus, bacillus of influenza, diplococcus lanceolatus, staphylococcus and the bacillus of diphtheria, the first two being the most important from their power to destroy tissue with great rapidity and from the diffusibility of their toxins. The toxins reach the eye way of the venous and lymphatic channels. Involvement of the eye is more likely to occur from infection in a thin-walled sinus or where dehiscences occur in the bony walls, producing direct contact between the lining membrane of the sinus and the orbital periosteum or even the sheath of the optic nerve. Adhesions may occur between the orbital periosteum or optic nerve sheath and the bony sinus walls secondary to inflammation of the latter, and these adhesions may become vascularized offering a direct route for infection of the ocular structures. Where the sinuses are large the likelihood of ocular involvement becomes greater owing to the increased number of venous, nerve and lymphatic communications.

According to Ziem (*Monatsschr. f. Ohrenheil.* u. s. w., Aug. 1893, S. 231), v. Zehender frequently employed blood-letting from the nose in cases of choroidal disease, thus emptying the nasal and orbital circulation of the toxic blood. Eversbusch (Die Erkrankungen des Auges in Beziehungen zu Erkankungen der Nase u. s. w. *Graefe-Saemisch Handbuch,* 2 aufl. 61 u. 62 lieferung, s. 65) has observed marked turgescence of the nasal tissues confined to the side of the first eye, preceding an outbreak of sympathetic ophthalmia in the second eye. He has also noted the disappearance of the nasal swelling following enucleation of the first eye. This phenomenon Eversbusch considers as a valuable aid in determining the time for enucleation. He reports a case of severe iridocyclitis of both eyes which had received thorough general and local treatment for one and one-half to two months without avail. Following the removal of hypertrophies of the inferior turbinal there was profuse nasal hemorrhage. The effect upon the eyes was remarkable. The eye which was more recently involved reacted more promptly. The ciliary injection disappeared at once, the vitreous opacities began to clear up, the iris reacted more promptly to the mydriatic and the vision improved. This improvement lasted ten days when an acute exacerbation occurred with marked swelling of the nasal mucous membrane, with secretion, necessitating enucleation of the first eye. Ziem (*Monatsschr. f. Ohrenheil. u. s. w.*, Aug. 1893, S. 231) reported improvement in vision in cataract cases following treatment of a coincident nasal infection. No change, however, could be seen in the lens opacities.

Two cases of intraocular hemorrhage are mentioned by Holmes (Head Pains and Eye Symptoms Caused by Inflammation of the Accessory Sinuses of the Nose. *Ohio State Med. Jour.* Feb. 1906), one being a circumscribed hemorrhage of the choroid with retinitis coming on twenty-four hours after the removal of a polypus and the cauterization of its base with the galvano-cautery. The other instance was one of intraocular hemorrhage which came on two months after an operation upon the middle turbinal and which Holmes considered to be due to the operation. Thigpen (*Trans. Sec. Ophthal. A. M. A.*, 1910) has also reported a case of sudden, severe intraocular hemorrhage due to sinus disease. He operated for a sphenoidal sinus empyema with necrosis which had caused a papilledema. The resulting intraocular hemorrhage proved so severe that a secondary glaucoma followed requiring enucleation. Few authentic cases of uveitis due to sinus disease have been recorded, which is remarkable considering the close relation existing between the nasal and ocular circulation. Posey (The Ocular Symptoms of Affections of the Accessory Sinuses of the Nose. *Trans. Sec. Ophthal A. M. A.*, 1905) suggests that there may be some controlling mechanism which prevents the ocular circulation from participating in the inflammatory conditions, just as there is a control of the intraocular circulation which makes it partially independent of the general circulation. Ziem (*Monatsschr. f. Ohrenheil. u. s. w.*, Aug. 1893, S. 231) is one of the few who claim that uveitis is caused in certain cases by sinus diseases. He believes that the route of infection is by way of the veins and lymphatics. He also states that papillitis was frequently observed as a result of disease of the sinuses.

When it comes to disturbances of the optic nerve, however, there is a gratifying uniformity of opinion amongst observers which points definitely to the nasal accessory sinuses as one of the chief sources of optic nerve disease. Onodi (The Oculo-Orbital, Intracranial and Cerebral Complications of Diseases of the Nasal Accessory Sinuses. *Laryngoscope,* Nov. 1909) has enriched the literature of this subject by his valuable studies showing the anatomical relations of the sinuses to the ocular structures. He gives the average width of the anterior orbital cells as 10 to 29 mm. and the posterior cells from 12 to 21 mm. These cells may encroach upon the superior orbital wall. The posterior ethmoidal cells extend into the area of the sphenoid bone and vary from 8 to 40 mm. in width. They may form part of the superior orbital wall and the wall of the canalis opticus on each side and extend into the sella turcica and the fissura orbitalis superior and the foramen rotundum. Onodi observed one sphenoidal sinus 6 cm. in diameter. The sphenoid may be in close relationship with one wall of the canalis opticus and with single segments of the sulcus opticus of either one or both sides. Either sinus may bound part of the canalis opticus and sulcus opticus of the opposite side. Perforation of one of the cerebral walls of the sphenoid may result in abscess and involvement of one optic nerve or of the chiasm and so of both nerves. Disease processes may extend through the lateral sphenoidal wall into the cavernous sinus producing thrombosis and involvement of the sixth nerve which lies within the sinus, and of the third and fourth nerves and ophthalmic division of the fifth nerve which lie in the outer sinus wall. Onodi describes what he calls a semi-canalis ethmoidalis, which consists of a group of veins protected by the sinus mucosa and extending from the anterior ethmoidal foramen along the wall of the frontal sinus or anterior orbital cells to the anterior cranial fossa. Congenital dehiscence of the superior orbital wall was seen with communication between the orbit and frontal sinus. Dehiscences of the orbital floor have been noted by Zuckerkandl and Merlin, according to Onodi, giving communication with the maxillary antrum. The orbital walls of the accessory sinuses are extremely thin, the floor of the frontal sinus being thickest. The bony walls between the posterior ethmoidal cells and the canalis opticus are usually of tissue-paper thickness, while the sphenoidal walls of the same canal may be from 1 to 12 mm. thick. The thicker the walls of the accessory cavities, the greater the protection to the orbital cavity, as well as the cranial cavity. Indirect infection of the orbit or optic nerve may occur from one sinus through another where there is a common partition wall, as described by Onodi. Zuckerkandl, quoted by Onodi, has described a communication between the maxillary sinus and the posterior ethmoidal cells, and Onodi has seen a similar communication of the antrum with the anterior ethmoidal cells. The frontal sinus has partition walls in common with the ethmoidal cells and the sphenoidal sinus. There may be an opening in the inter-frontal partition forming one large frontal sinus. Either sphenoidal cavity or both may have partition walls in common with the posterior ethmoidal cells of either or both sides. These walls are usually very thin and easily diseased.

The venous system is another means of carrying infective processes from the nose to the orbit. The frontal sinus veins run along the sinus floor communicating with the vena frontalis or vena supraorbitalis. The anterior and posterior ethmoidal veins empty into the superior ophthalmic vein. There is free anastomosis between the superior and inferior ophthalmic veins and the anterior and posterior ethmoidal veins and the central retinal vein. The ophthalmic veins further communicate with the facial veins, the pterygoid plexus and the cavernous sinus. Occasionally the central retinal vein connects directly with the cavernous sinus. Veins from the sphenoid join the ophthalmic veins and the cavernous sinus. The veins of the various sinuses anastomose with each other and with the orbital plexus. The close relation of the nasal and orbital veins may lead to orbital infection or thrombosis of the ophthalmic veins, or thrombophlebitis of the central retinal vein. The venous stenosis which may occur in the sulcus opticus and canalis opticus from their close relation with the posterior ethmoidal cells or sphenoidal sinus may be very destructive to the optic nerve, causing retrobulbar neuritis, thrombosis or embolism of the central retinal vessels or hemorrhage into the optic nerve sheath, resulting in visual disturbances more or less permanent. Loeb's contributions to the anatomy of this region have been dealt with at length in the sections on the anatomy of the sinuses.

The papillo-macular bundle of the optic nerve is the most vulnerable portion, due to its high organization and its proximity to the central vessels of the nerve which are involved in circulatory disturbances arising in the sinuses. This process is thought by some, notably Birch-Hirschfeld (Die Beziehungen der Entzündlichen Orbitalerkrankungen zu den Erkrankungen der Nebenhöhlen der Nase. *Klin. Monats. f. Augenheil.,* Jan. 1908, S. 1), to be toxemia due to venous stasis. Involvement of the papillo-macular bundle is shown by the presence of a central scotoma. This scotoma may disappear with drainage of an infected sinus, or the optic nerve may go on to atrophy. The most dangerous area of the optic nerve is within the canalis opticus, where circulatory or inflammatory disturbances may injure the nerve through pressure, especially this sensitive papillo-macular bundle. Baratoux, quoted by Onodi (The Oculo-orbital, Intracranial, and Cerebral Complications of Diseases of the Nasal Accessory Sinuses. *Laryngoscope,* Nov. 1909), describes a case of exfoliation of the greater part of the body of the sphenoid bone without visual disturbance, but these cases are undoubtedly of the class which show a dense wall of bone, sometimes of 12 mm. thickness, between the canalis opticus and the cells.

Differential diagnosis is, of course, necessary to establish the true origin of optic nerve disease, whether due to sinus disease, tobacco and alcohol poisoning, thrombosis of the cavernous sinus or brain tumor. Axenfeld (*The Lancet,* Aug. 8, 1908) calls attention to the frequency with which it has been asserted that chills marked the onset of a retrobular neuritis and believes that disease of the nasal sinuses supplies the connecting link. He also states that transient inflammation of the lining membrane of the posterior cells may be the cause of a retrobulbar neuritis even in the absence of empyema, the cause being defects in the walls of the optic canal.

Vridenberg (Visual Symptoms of Accessory Sinus Disease. *Ophthalmology,* Jan. 1913, pp. 186) states that optic nerve disturbance due to disease of the posterior cells practically always takes the form of a retrobulbar neuritis, toxic in type, as the findings are almost identical with those recognized to be due to alcohol, tobacco and other poisons.

Vander Hoeve (*Archiv. f. Augenheil.* Bd. 64, 1909, Heft 1) reports a case of double optic neuritis of nasal origin uninfluenced by operation on the sinuses of one side but relieved by operation upon the second side, showing an anatomically close relation between the cells of that side with the optic nerve and very slight relation with the cells first operated upon. A definite infection is not necessary to bring about disturbances in the optic nerves. Where the nasal anatomy is abnormal, easily causing a blocking of the ostia of the posterior cells during an acute rhinitis, varying degrees of congestion of the cell membrane may be produced even to a marked edema which extends to the optic nerve where the conditions are favorable.

It has been suggested by Bruckner (Nase u. Auge in ihren Wechselseitigen Beziehungen. *Würzburger Abhandl,* 1911) that many cases of retrobulbar neuritis formerly attributed to influenza, typhoid, rheumatism, etc., were really of nasal origin. There is today no dearth of evidence as to the importance of the role played by the sinuses in optic nerve affections.

Krauss (*Ophthalmic Record,* May 1909) strongly emphasizes the finding of a central scotoma in chronic accessory sinus disease indicating retrobulbar neuritis. He considers that the neuritis is toxic in origin rather than inflammatory, as it disappears with astonishing rapidity after drainage of the diseased sinuses and also because there is a selective action on the macular fibers similar to that found in the toxic amblyopia.

Piffis (*Zeitschr. f. Ohrenheilk*, Bd. 63 H. 3) found 7 cases of sinus disease in 37 cases of retrobulbar optic neuritis. De Kleyns (Graefe's *Archiv.* Bd. 75, H. 35 n. Bd. 79, H. 3.) systematically examined his cases of posterior ethmoidal and sphenoidal disease and claims to have found at least a beginning neuritis in every one. Onodi (*Berlin Klin. Wochenschr*, 1911, No. 35) has observed many cases of sinus suppuration with relative central scotoma and 3 cases with enlargement of the blind spot, 2 of which also showed central scotoma.

It is certain that such findings are frequently overlooked, especially the enlargement of the blind spot, which has a very definite value as one of the earliest symptoms of involvement of the optic nerve. Edin (*Jour. Laryng., Rhinol. and Otol.* October 1911) reports ninety per cent. of his cases of sinus disease as showing contraction of the visual fields.

Markbreiter (*Monatsschr. f. Ohrenheilk*, Bd. 46 H. 5) was unable to find any constant relation between visual field contraction and sinus disease although frequently the phenomenon was noted. Also scotomata and enlargement of the blind spot were not found with sufficient frequence to furnish grounds for a diagnosis of sinus disease. Other authors also have failed to find these eye symptoms in their cases of sinus disease in spite of thorough and repeated examinations, the reason lying undoubtedly in the extremely variable anatomical relations. These negative findings should not lessen the importance of the sinus-eye relationship however, after exhaustive search fails to establish a definite etiology in a case of optic neuritis, the sinuses should be thoroughly investigated. It does no harm to open the anterior sphenoidal wall or to remove some of the posterior ethmoidal cells, and in a doubtful case it should be done rather than sit quietly by and watch such a case go on to blindness. In making a differential diagnosis in a case of optic neuritis or retrobulbar neuritis, the chief causes to be sought are toxic amblyopia, multiple sclerosis, as contended by Langenbeck (*Berlin. Klin. Wochenschr.* 1912, No. 15. S. 719) who observed 77 cases of retrobulbar neuritis in Uhthoff's clinic, the majority of which were found to be due to multiple sclerosis, hemorrhage, diabetes, severe exposure to cold, acute infectious diseases and intracranial complications. The fact that a given disturbance of the optic nerve is unilateral is merely significant of accessory sinus disease, as the toxic amblyopias, as well as the type due to multiple sclerosis, may also be unilateral. On the other hand, the disease of the accessory sinuses has been known to produce bilateral optic nerve disease where one sphenoidal cell is anatomically in close relation to both optic nerves.

A suppurative process in the cells is not necessary to cause damage to the optic nerve. Many cases have been recorded where at operation only a thickened edematous mucosa was found, the affection of the optic nerve being due to the resulting circulatory disturbance producing edema and pressure on the optic nerve in the optic canal.

Probably the youngest case of blindness from nasal disease is that reported by Stenger (*Therapie der Gegenwart*. June 1912). A child 3½ years of age became totally blind and vision and normal pupillary reactions were restored by the removal of an adenoid mass and of both swollen middle turbinals, together with a portion of the ethmoidal labyrinth.

Early and thoroughly carried out operation upon the affected nasal sinuses to secure and maintain free drainage is indicated. A favorable symptom in the optic nerve cases is the improvement in vision which frequently follows the thorough contraction of the swollen nasal mucosa with cocain and suprarenalin. In such an event we may reasonably expect a satisfactory result from the re-establishment of free communication between the diseased cells and the nasal cavity.

A case of bilateral detachment of the retina which was completely cured by treatment of underlying nasal disease has been reported by Widmark (*Ophthalmic Review,* Sept., 1908, p. 280). He found polypoid degeneration of the mucous membrane of the ethmoidal cells, maxillary sinus empyema and accompanying orbital inflammation. Treatment of the nasal condition was followed in twelve days by disappearance of the detachment in the right eye with vision of 9/10. The left eye recovered more slowly, the detachment disappearing at the end of a month. Teillais (*Ann. d'Oculist.,* July 1907) reports a case of acute maxillary sinusitis with subsequent infection of all the other sinuses of the same side except the frontal, which caused an orbital abscess. Sudden blindness came on in three weeks after the development of the orbital symptoms. A month later neuro-retinitis developed in the other eye, although none of the sinuses of that side was infected. Enucleation of the first eye was followed by improvement in vision in the second eye and the neuro-retinitis gradually disappeared. Teillais believes that the neuro-retinitis was due to sympathetic ophthalmia.

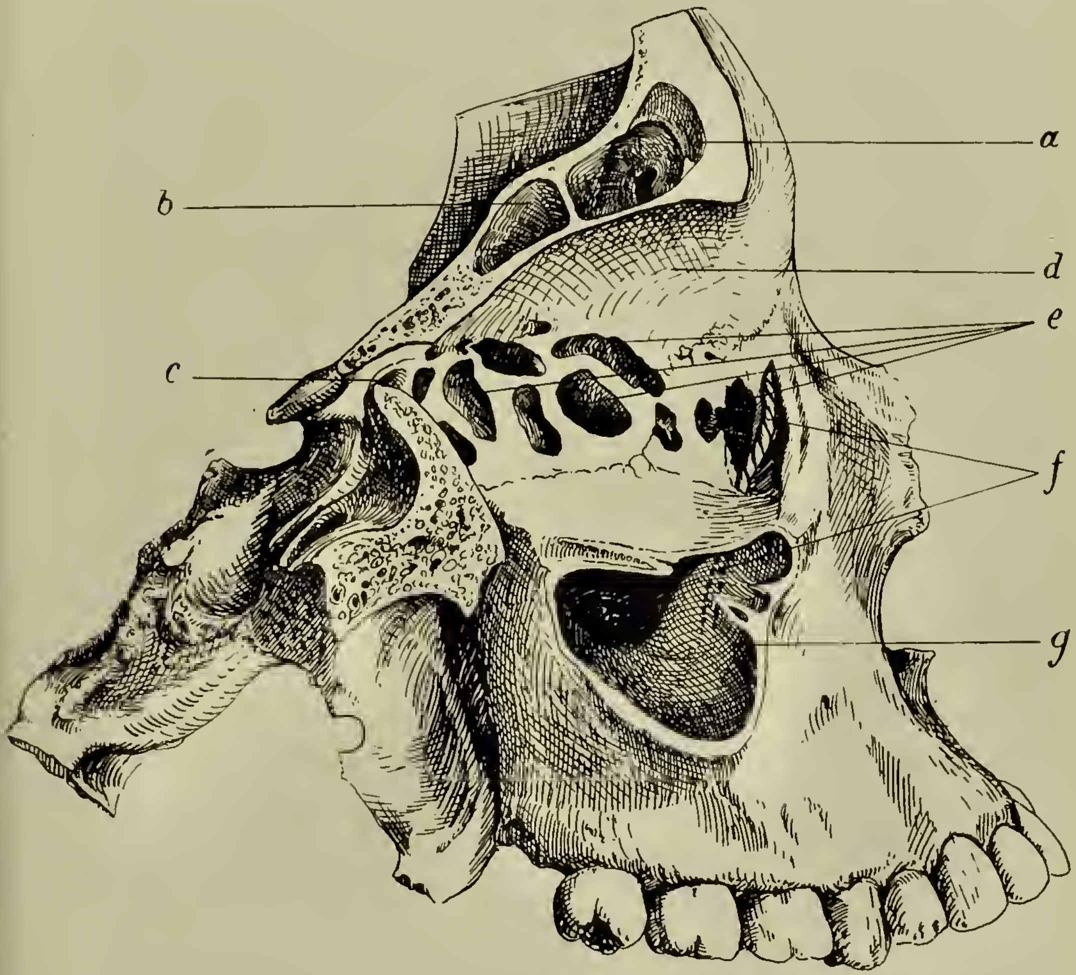
Posey (Some Ocular Symptoms of Diseases of the Nasal Sinuses. *Annals of Otol., Rhin. and Laryn.,* June 1909, p. 354) refers to a group of cases of retrobulbar edema of the optic nerve secondary to acute inflammation of the ethmoidal and sphenoidal cells following sea-bathing. The findings are hazy vision, diminution of light sense, central scotomata and pain on pressing the globe backward into the orbit. Occasionally some blurring of the nerve head and a partially dilated pupil have been observed.

Birch-Hirschfeld (Die Beziehungen der Entzündlichen Orbitalerkrankungen der Nebenhöhlen der Nase. *Klin. Monats. f. Augenheil.* Jan. 1908, S. 1.) in a series of 409 cases of orbital involvement due to sinus disease, noted the occurrence of blindness in 16 per cent. The blindness resulted from antrum disease in 24 cases, from frontal sinus disease in only 6 cases, while disease of the ethmoidal cells caused blindness in 13 cases. In the cases due to disease of the maxillary sinus, thrombophlebitis of the central vein of the optic nerve was shown microscopically to have been the immediate cause of the blindness. These statistics emphasize the fact that the methods employed by ophthalmologists in the past have not only proved inadequate but dangerous. Ophthalmologists, notably Kuhnt, have already added much to our knowledge of the diagnosis of disease of the nasal accessory sinuses and have aided in developing operative methods upon these sinuses. It now becomes necessary for the oculist to become proficient in this work himself, or to refer such cases to a competent rhinologist.

Orbit. It is now universally accepted that orbital inflammation is due in almost every instance to extension of a disease process from the accessory sinuses of the nose. According to Gerber (Die Complicationen der Stirnhöhlenenzündungen, 1909. S. 206.) the first to promote this idea was Germann. Even as late as the year 1882 practically no general knowledge existed of the relation of the nasal sinuses to the orbit. A dissertation by Schwendt (Uber Orbitalphlegmone. Dissertation Basel, 1882) published in 1882, contained no reference to the accessory sinuses as a cause of orbital disease. One of the earliest to emphasize the importance of examining the nose and accessory cavities where orbital disease existed was Beer (*Lehre von den Augenkrankheiten,* Wien, 1817). From the time of Beer, Germann and others the knowledge of these relations had so greatly increased that the statement is made in a recent exhaustive study of the subject by Birch-Hirschfeld (Die Beziehungen der Entzündlichen Orbitalerkrankungen zu den Erkrankungen der Nebenhöhlen der Nase. *Klin. Monats. f. Augenheil.* 1908, S. 1) that practically all orbital inflammations are due to empyema of the nasal accessory sinuses.

The earliest symptoms of orbital involvement are usually swelling of the eyelids, particularly the upper, and widening of the lid aperture. Later the lids may become red and brawny and distinct displacement of the eye occurs. The direction in which the eye is displaced gives a general idea of the location of the sinus disease. In frontal sinus disease the globe is pushed downward and outward, in ethmoidal disease outward and sometimes upward, and in sphenoidal disease proptosis occurs almost directly forward.

When edema of the lids recurs frequently or becomes persistent, and tenderness of the orbital walls is present, the diagnosis of orbital involvement is practically certain. Nasal examination at this time should give positive evidence of sinus disease, the location of which would determine the character of the operative procedure. In this stage the orbit frequently contains no pus, as noted in one of the author's cases showing extreme proptosis outward, which at operation revealed a periostitis of the os planum with abscess in the posterior ethmoidal cells, but no pus in the orbit. In such instances the orbital process is due to toxins which frequently produce simultaneous dis-



View of the Frontal Sinus and Neighboring Cavities in Their Relation to the Orbit.

a, Frontal sinus; b, Anterior ethmoidal cell; c, Optic nerve canal; d, Inner orbital wall; e, Ethmoidal labyrinth; f, Lacrimo-nasal duct shown by thread; g, Maxillary antrum.

turbances of the optic nerve and other ocular structures. Orbital abscess varies in degree from the appearance of a small fluctuating tumor near the inner canthus of the eye to the most severe manifestations, such as phlegmon of the eyelids, chemosis of the conjunctiva of the lids and globe, dislocation of the globe, which may become so extreme as to produce complete immobilization and panophthalmitis.

It is seldom difficult to decide whether the process in the orbit is secondary to a mucocele or to an empyema of one of the accessory sinuses, as the mucoceles are so slow in producing a displacement of the globe that the ocular structures accommodate themselves to the changed conditions and no serious ocular symptoms result.

The frontal sinus and ethmoidal cells are most frequently the source of orbital complications, the thinnest wall of the frontal sinus forming the orbital roof and the thin lamina papyracea of the ethmoid forming almost the entire inner wall of the orbit. It is probable that the ethmoidal cells are even more frequently the etiologic factor than formerly believed, owing to the greater difficulty in diagnosing ethmoidal disease.

Chronic orbital and accessory sinus abscesses may be discovered only when a fistula appears. A fistula of the frontal sinus may appear at any point along the orbital margin, but is most frequently seen near the inner canthus, where it may simulate lacrimal sac abscess.

The most recent and complete statistics upon the frequency of orbital disease due to disease of the nasal accessory sinuses are those of Birch-Hirschfeld (Die Beziehungen der Entzündlichen Orbitalerkrankungen zu den Erkrankungen der Nebenhöhlen der Nase. *Klin. Monats. f. Augenheil.,* Jan. 1908, S. 1). Of 684 cases of orbital disease, 409 (59.2 per cent.) were found to be due to sinus disease. This percentage should in reality be higher as many of the cases received no nasal examination whatever.

Excepting the nasal sinuses, the blood-stream offers the only means aside from traumatism for infectious material to reach the orbit. On the other hand, we find the orbit surrounded with thin-walled cells often containing defects and participating in the frequent inflammations and infective processes within the nose. The conclusions are obvious. Birch-Hirschfeld has also drawn attention to the fact that sinus infections tend to heal while the orbital process which originated from the sinus infection tends to progress. Thus we may be deceived during operation by finding the sinuses practically normal while a well developed orbital infection exists.

The frontal sinus in Birch-Hirschfeld's series caused orbital disease in 129 cases (29.8 per cent.), the maxillary sinus in 89 cases (21.8

per cent.), the ethmoidal labyrinth in 83 cases (20.5 per cent.), and the sphenoidal sinus in 25 cases (6.1 per cent.). In 60 cases (14.7 per cent.) more than one sinus was involved, 25 cases showing associated disease of the frontal and ethmoidal cells, 12 cases disease of the ethmoidal and maxillary sinuses and 10 cases showing coincident involvement of the sphenoidal and ethmoidal cells. The sinus infections were of the chronic suppurative and acute sinusitis type, following rhinitis, influenza, pneumonia, scarlet fever, diphtheria or trauma. Birch-Hirschfeld believes that the infective process reaches the orbit as a result of the suppurative inflammation of the lining mucous membrane of the sinuses, which in turn causes disease of the periosteum with ostitis, caries or necrosis of the bone wall. The selective areas are found where the blood vessels perforate the bony wall and where the periosteum is poorly developed. In the frontal sinus this area is found at the sinus floor, in the ethmoidal labyrinth at the lamina papyracea and in the antrum at the orbital plate. Dehiscences in the bony walls also offer opportunity for the progress of the infective process. It is not absolutely necessary to have actual perforation, as a thrombo-phlebitis process may be the means of reaching the orbit, as Birch-Hirschfeld was able to demonstrate anatomically in one case. The orbital process frequently is subperiosteal with marked lid swelling and spontaneous drainage through the lid or conjunctiva.

Orbital cellulitis may be produced by extension of the inflammatory process along the veins as has been demonstrated anatomically. The lymphatics, about which little is definitely known, probably also play a part, as do the variety and virulence of the infecting organisms. Bull (Mixed Streptococcus and Pneumococcus Infection of the Orbit and Adjacent Sinuses. *Annals of Ophthal.* October 1908) has observed the extreme violence which usually attends infection of the orbit and accessory sinuses where the streptococci or pneumococci are present. He has reported six cases of mixed streptococcus and pneumococcus infections, all of which occurred in young persons, and which exhibited the most severe symptoms. One of the earlier cases showing violent reaction was that of Carver (*British Med. Jour.*, June 16, 1883, p. 1182.) He describes a case of orbital abscess showing proptosis. An incision was made through the swollen upper eyelid to drain the abscess, but death resulted in six days. At the post mortem examination the bone of the orbital roof was found to be dry and yellowish and denuded of periosteum. Both frontal sinuses contained pus, as did the superior longitudinal sinus. Pus also covered the "convolutions of the brain." There was a history of pus discharge from the nose on the side corresponding to the orbital abscess for many years. Krauss (*New York Med. Jour.,* April 24, 1909) has reported two cases of acute suppurative or phlegmonous ethmoiditis which resulted fatally. He considers them to represent a type of case which always shows the most severe symptoms, the patients seeming to have no resistance to the infection. The general and cerebral circulations become involved through the vascular system draining the accessory sinuses and death results from toxemia, pyemia, meningitis, thrombosis of the cavernous sinus or brain abscess. The indications for operation in acute ethmoiditis, according to Krauss, are sudden increase in temperature, delirium at night, tumor formation at the inner orbital angle, and the slightest degree of exophthalmus. A somewhat similar case occurred in the author's practice, except that the sphenoidal sinus was the source of the infection. The patient was 76 years of age and had suffered from very severe headache for six weeks, accompanied by unilateral optic neuritis, finally resulting in complete blindness. Skiagraphs were negative, thus excluding all the sinuses except the sphenoidal which cannot be shown accurately. Careful nasal examinations on four successive days revealed muco-pus draining backward into the naso-pharynx on the corresponding side, following the application of the suction pump. The anterior wall of the sphenoidal sinus was then removed and the lining membrane found to be discolored and thickened. Drainage of pus was noted a few hours after operation and a closer examination with a probe revealed rough bone at the supero-external angle of the sinus. The headache was at once relieved so that opiates, which had been continuously used for six weeks, were stopped. In spite of the drainage, however, there was a gradual extension of the process to the meninges and death resulted fourteen days after the operation, the pulse gradually increasing to 160 beats per minute and the temperature rising to 106°F. Four days after the operation there was dusky swelling of the eyelids with edema of the bulbar and palpebral conjunctiva which gradually subsided, however. The blood cultures showed streptococci in small numbers and the blood count showed 90 per cent. polymorphonuclear leucocytes and 20,000 white cells. No "steeple" temperature was noted at any time. The drainage of pus which was at first copious, gradually lessened under irrigations of sterile physiological saline solution, followed by instillation of 10 per cent. argyrol into the sphenoidal sinus.

Hansell (Orbital Complications of Diseases of the Frontal Sinus. *Annals of Otol., Rhin. and Laryn.,* June 1909) reports a case where a pus sac from a perforation of the frontal sinus produced displacement of the globe downward and outward, with lowered vision, ptosis and severe pain. Two injuries to the brow occurred five years or more before the appearance of the eye symptoms. An exploratory incision revealed the pus sac and large perforation of the frontal floor with necrotic areas along the orbital roof almost to the apex. A drainage tube left for two days relieved the condition.

Turner (*Edin. Med. Jour.*, May 1909) reports six cases of acute suppuration in the anterior group of sinuses with eye symptoms, such as edema and redness of one or both lids, one case having proptosis, vertical diplopia and subperiosteal abscess. Three of the cases were subperiosteal abscess and recovered following drainage, although in none of the cases was the origin of the infection located and remains problematic as the frontal sinus was not investigated, although the ethmoidal cells were opened and found normal and the orbital walls seemed normal. The pneumococcus was the infecting organism in two cases which required a radical operation, the simpler drainage not sufficing. In only one case were the eye symptoms prominent, the others showing no fundus lesions or pupillary abnormalities. This one case was a child who was struck on the nose. Hemorrhage followed and the eyelids began to swell the next day. Seven days later the lids were swollen shut, the ocular conjunctiva below was edematous, there was a corneal ulcer and no P. L. The swollen lids prevented a fundus examination. Incision through the upper eyelid revealed foul-smelling pus and gas. There was a mixed infection present, the smears containing a Gram-positive bacillus filamentous in character and the cultures showing a pure culture of staphylococcus albus. Drainage of the abscess revealed rough necrotic orbital walls with perforation into the nose through the ethmoidal cells. Improvement followed but nearly one month later meningitis suddenly appeared and death resulted. Autopsy revealed a brain abscess communicating with the orbit through a circular perforation in the roof and a basal leptomeningitis which seemed to be due to extension from an infected cavernous sinus, although the frontal, ethmoidal and sphenoidal sinuses on the same side were infected, but presented no perforations.

Chiari and Marschik (*Med. Klinik,* No. 16, 1908) report twenty-two cases of orbital phenomena resulting from accessory sinus disease and conclude that the infection arises from the ethmoidal cells more frequently than from the other sinuses. In the earlier reports the maxillary sinus was considered the most frequent source of orbital disease, but as our methods of diagnosis have improved disease of the ethmoidal and sphenoidal sinuses is being more frequently recognized as the chief factor in this class of cases. The author recently operated upon a case of subperiosteal orbital abscess which showed a perforation of the os planum one centimeter in diameter, yet it had been said that the maxillary sinus was the probable source of the infection.

Knapp (*Archiv. of Otology.*, Vol. XXXII, No. 3, 1903) reports a case of bilateral nasal discharge with polypi, gradual distension of the ethmoidal cells with "frog-face" deformity, so extensive that no orbital tissue was found between the eyeballs and the os planum. The floors of both frontal sinuses were removed with the lacrimal bone, and the os planum on each side was also removed, revealing the lining membrane of the frontal sinuses covered with granulations and greenish pus. The ethmoidal cells were cystic and filled with polypoid degenerated mucous membrane. The process extended under the periosteum of the frontal and temporal bones and several abscesses were incised in this region and back over the scalp and over the right mastoid which was the seat of an old otorrhea. The osteomyelitis extended upward in the diploë of the frontal bone and the abscesses showed streptococci. Double optic neuritis with hemorrhages occurred four days after operation. Autopsy showed epidural abscess and sigmoid sinus thrombosis, and the antra and sphenoidal sinuses contained pus.

Krauss (Report of Antral Disease in Four Months Child with Orbital Symptoms. *Archives of Ophthal.* March, 1912, p. 150) has reported a case of acute infection of the maxillary sinus in a child 4 months of age which was operated by the alveolar route with a counter opening into the nose. Two large hard teeth were found in the infected sinus. The palatal plate of the corresponding superior maxilla was found to be movable and there was an extension of the abscess into the orbit. It is a question whether this was a true antral infection or an osteomyelitis of the superior maxilla. The maxillary sinus is undoubtedly present at birth and has been found as early as 6½ months in the fetus. It is probable that most cases of osteomyelitis of the superior maxilla begin as antrum infection and because of the lack of development of the facial bones the infection extends easily to the surrounding tissues.

Knapp (*Amer. Jour. Med. Sciences,* July, 1909) has recently made the statement that external or orbital inflammatory symptoms occur whenever the bony wall between the infected sinus and the orbit becomes diseased. The fundus findings he has observed have varied from slight venous congestion of the optic disc to papillitis which may be more marked on the nasal side of the disc. A central scotoma is a characteristic finding.

Posey in a personal communication to the author refers to the difficulty in diagnosis between orbital new growths and orbital cellulitis and abscess from accessory sinus disease. He believes that one should always be prepared to do a Kroenlein operation when operating upon the accessory sinuses through the orbit. The blood count in these cases would be of the greatest service in deciding between a tumor and a cellulitis, as well as the temperature curve, the nasal findings and skiagraphs. Posey (The Position of the Ophthalmologist in the Treatment of Diseases of the Accessory Sinuses of the Nose. *Ophthalmic Record,* August, 1907, p. 363), in this connection, has reported a case of mucocele of the frontal cells producing proptosis with lid edema, where the nasal findings were practically negative. An operation consisting of an incision along the eyebrow exposed the mucocele which when opened was found to contain a large quantity of clear gelatinous fluid. The finger could easily be introduced into the frontal cells, which were greatly enlarged. The patient died a few days later of uremia.

Another condition that may be confused with orbital or lacrimal sac disease is encephalocele. Hopkins (*Trans. Amer. Laryngol. Assn.,* 1906) has reported such a case of fronto-nasal encephalocele. The cerebral hernia presented as a small swelling over the right nasal bone and at operation a small rounded mass was removed from the outer nasal wall near the anterior end of the inferior turbinal. A second globular tumor, smooth, gray and semi-translucent, was next seen at the level of the middle turbinal. Pressure upon this mass increased the external swelling. No further operating was attempted and two weeks later the child died of meningitis. Hopkins concludes that operation upon cerebral hernia in the nose is not justifiable owing to sepsis.

Frontal sinus. The two frontal sinuses lie between the inner and outer tables of the frontal bone, bounded anteriorly by the superciliary eminences, below by the orbit and posteriorly by the cranial cavity. The dimensions of these sinuses vary greatly. Logan Turner (*Accessory Sinuses of the Nose,* 1902, p. 23) gives the following measurements as the average: Height 31.6 mm.; breadth 25.8 mm.; depth 18 mm. The smallest sinus which he found had a height of 18 mm., a breadth of 13 mm. and a depth of 5 mm., while the largest had a height of 45 mm., a breadth of 60 mm. and a depth of 25 mm. Loeb's (*Annals of Otol. and Rhin.,* June 1907) frontal sinus measurements show the antero-posterior diameter to vary from 9 to 33 mm.; the supero-inferior from 14 to 51 mm. and the lateral from 7 to 42 mm.

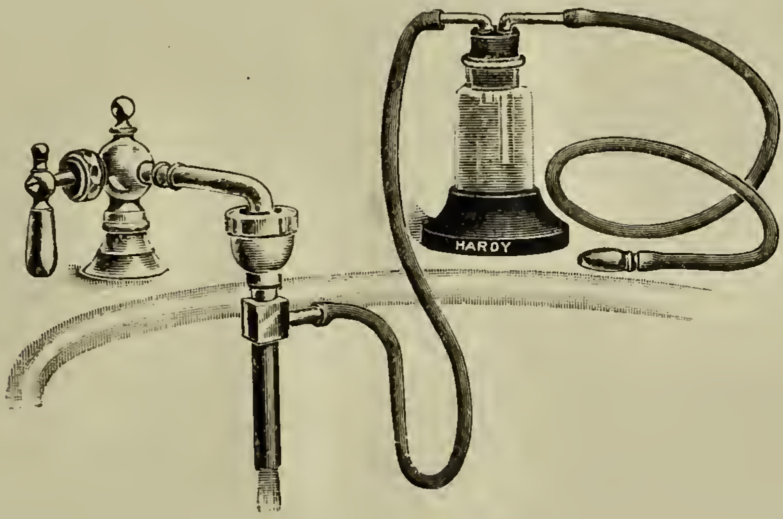
A vertical septum, approximately in the median line, separates the two cells, although in exceptional instances it is absent. Partial partitions frequently occur producing irregular recesses which are so frequently the means of continuing a chronic empyema unless recognized and removed radically.

The frontal sinus is not present at birth, but begins to develop usually about the beginning of the second year as an extension of the ethmoid cells. It reaches a size sufficient to be recognized as a frontal sinus extending above the supraorbital margin at about the seventh year. Symington (*Anatomy of the Child*, Edinburgh, 1887) reports two instances where well-developed frontal sinuses were found at the age of 9 and 13 years, none being found in children under 6 years of age. These findings possess only a relative value, as the variations are so great that the only reliable information regarding the shape and extent of these cells is to be obtained by Röntgen ray photographs. In the absence of this valuable aid the sinus should always be opened at the lowest point of the anterior wall near the median line. The septum frontale has a fairly constant location in the median line of the head so that the smallest sinus may be safely opened at this point.

The orbital wall is the thinnest, being especially thin at the upper inner angle of the orbit where fistulæ most frequently occur in chronic frontal sinusitis. Occasional defects have been found in the orbital wall giving even more direct communication between the orbit and the frontal sinus. Near the median line the floor of the sinus lies contiguous to the ethmoid labyrinth.

The ostium frontale, by means of which the frontal sinus communicates with the nose, lies at the lowest part of the sinus at its anterior angle near the septum frontale. The ostium is always present when a frontal sinus exists at all as it forms a part in the development of the frontal sinus from the ethmoid cells. The ostium varies in size in different cases, which accounts for the fact that some sinuses drain so much more easily than others. Drainage of this cell is also frequently interfered with at a lower point in the hiatus semilunaris where an unusually close approximation of the bulla and uncinate process of the ethmoid occurs, as suggested by Ewing and Sluder (*Trans. Am. Opthal. Soc.*, May 2nd, 1900). The fronto-nasal duct may also be encroached upon by small ethmoidal cells or even by the large ethmoidal cell which is sometimes found pushed upward into the frontal sinus. These anatomical variations complicate the diagnosis in supposed frontal sinus infections as from such cells pus is to be seen directly in the region of the fronto-nasal duct and a probe passed into such a "bulla frontalis" as Zuckerkandl has named it, is naturally thought to be in the frontal sinus itself. These various developmental combinations all unite to make it more difficult to find and probe the front-nasal duct which is so important from the standpoint of diagnosis and treatment.

The first to devise a method for inducing a vacuum within the nose was Seyffert (*Sitzungsberichte der Physikal Medizin Gesell.* Würzburg Apr. 29, 1899) who performed what he called a negative Politzerization. The patient was required to swallow a little water when a previously compressed Politzer bag was released, producing suction for an instant. This procedure was then repeated as often as desired. Spiess (*Müenchen Med. Wochenschr.,* No. 1, 1905) and Sondermann (*Archiv. f. Laryngol.,* Md. 17, Heft 2) have used the suction treatment for various forms of "catarrh" of the upper air passages. Sondermann uses a rubber bulb attached to a mask which fits over the nose and mouth while Spiess employs a three-way vacuum pump attached to an electric motor. The author tried the latter method, using a Pynchon pump attached to a quarter-horsepower electric motor, but it did not prove satisfactory. The degree of suction was difficult to regulate and the steel ball valves of the pump quickly oxidized in the excessive moisture absorbed by the air withdrawn from the nose. Suction is now obtained by a simple water pump of the type used in pharmaceutical laboratories for forced filtration. The device is fastened to a cold water faucet by means of a shower-bath attachment. A large glass bottle is used to catch secretion from the nose and prevent blocking of the pump. A tube with a nasal tip for each nostril is occasionally used, but the single olive-shaped hard rubber tip is more frequently employed, as it is easily adjusted in every shape of nostril, the opposite side being then closed by the finger. The patient is



Author's Accessory Sinus Suction Apparatus.

instructed to take a long breath and gently say "hick," holding the soft palate in the position it is thus made to assume. This closes the nares posteriorly and by turning on the water any desired force may be obtained. The soft palate usually rises without difficulty into its position against the posterior pharnyx wall and is then held in place by the force of the suction. Patients who experience difficulty in learning to manage the palate, may try various ways, such as swallowing slowly, sounding a prolonged ee or holding the tongue and soft palate in the position required to form the first half of the letter k, omitting the explosive sound which completes the letter. The nasal tip should be placed in such a position in the nostril that the opening cannot come in contact with the septum or external wall of the vestibule as the force would be expended at these points only, causing pain and producing no results within the nose. The tip should be pushed firmly into the nostril as the ala may collapse with the negative pressure and close the opening in the tip.

Martens (*Deutsche Med. Wochen.*, Jan. 18, 1909) used a pump to which is attached a vacuum meter. He feels that it is an advantage to be able to measure the force of the negative pressure used, and finds that a force varying from fifteen to twenty-five mm. of mercury is sufficient. The author finds this water suction pump invaluable in the diagnosis of accessory nasal sinus infections and has met with success also in treating the chronic types, especially in the ethmoidal cells in cases which for any reason cannot be operated upon. In addition to the mechanical drainage obtained a local hyperemia is induced after the principle of Bier (*Hyperemic Treatment,* 1908) which is a valuable factor. As applied in diagnosis of frontal sinusitis, the secretion is carefully wiped away from the middle turbinal and middle meatus and suction used for five minutes when the secretion will be seen to reappear high up under the middle turbinal. The increased drainage thus obtained is capable in uncomplicated cases of effecting a cure.

Diagnosis. The diagnosis of disease of the frontal sinus depends upon characteristic symptoms which are present with greater regularity than are those of the other accessory sinuses.

Acute frontal sinusitis occurs secondary to an acute rhinitis and begins with a sensation of heaviness and pressure above the eye accompanied by malaise and fever. The pain may become very severe and frequently is described as of a "bursting" character. Percussion over the sinus area is painful and pressure at the inner upper orbital angle against the sinus floor elicits tenderness. Stooping increases the pain and is frequently followed by a slight vertigo. Blurring of vision, insufficiency of the internal recti muscles of the eye and narrowed visual fields are occasionally observed. Accommodative asthenopia may occur, amounting in some instances to actual pain on attempting to use the eye, with photophobia and lacrimation. These symptoms may be the only evidence of disturbance in the frontal sinus particularly in the non-suppurative type described by the author (*Trans. Section of Ophthalmology, A. M. A.*, 1906).

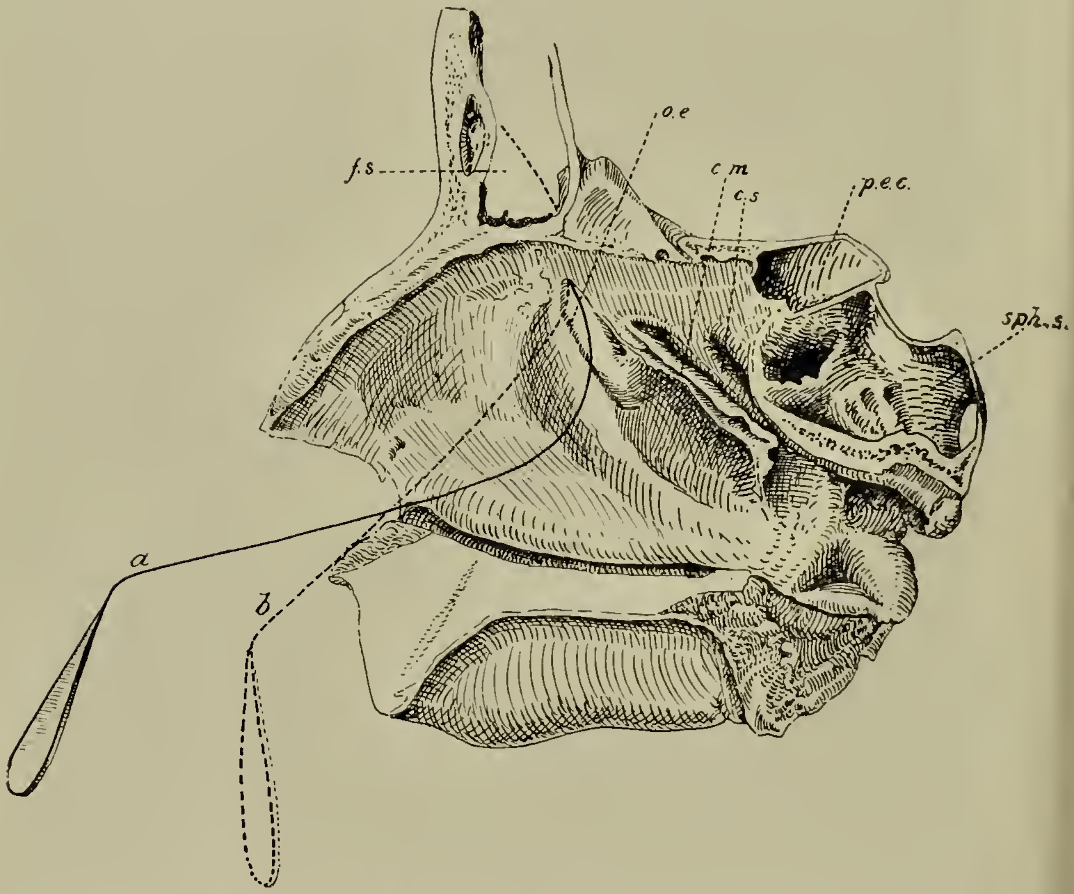
A fistula of the frontal sinus may produce an abscess at the inner canthus simulating abscess of the lacrimal sac, and the diagnosis may be further complicated by perforation into the lacrimal sac. Edema of the corresponding upper eye-lid, or in very severe cases redness and swelling over the frontal region as well as the eye-lid, may be noted.

Chronic cases frequently show no tenderness of the sinus walls and the local pain is not usually so great, although severe headache may occur, the diagnosis depending chiefly upon the presence of secretion in the upper anterior part of the middle meatus and the findings by probing and irrigating the sinus. Extreme cases may show fistulæ or dilatation of the bony sinus walls. The pain frequently occurs at or about the same hour of the day, lasts a definite time and ceases at a certain hour.

Certain diagnosis of empyema of the frontal sinus may be made when pus follows the passage of a probe into the sinus or is washed from the sinus with a curved cannula, all secretion having been previously removed from the nares. The author's suction pump is useful in cases where for any reason the sinuses cannot be probed. Hajek and Jurasz (*Nebenhöhlen der Nase,* S. 162) state that at least 50 per cent. of the frontal sinuses cannot be probed.

Transillumination of the sinus has a corroborative value but in view of the possibility of error, due to variations in the thickness of the bony walls or periosteum, the finding of a shadow is not conclusive. Röntgen ray photographs, however, are of the greater value, especially in cases with negative nasal findings. Such cases have occurred in the writer's practice showing marked subjective symptoms, but no secretion could be seen at frequent examinations and none was obtained by repeated use of the suction apparatus. The X-ray plate, however, revealed characteristic shadows and the sinus disease was confirmed by operation. In one case after unsuccessful use of the suction pump on four successive days, the X-ray plate showed shadows in the frontal and anterior ethmoidal region. A few days later all symptoms were relieved by a copious flow of pus from the nose, doubtless due to the dilution of the thickened secretion within the cells by the excess mucous secretion which is always produced by the suction pump.

Probing the frontal sinus may be rendered difficult by the presence of a high deviation of the septum, too close application of the middle turbinal to the lateral nasal wall, a narrowed hiatus semilunaris or the presence of polypoid hypertrophies or acute edematous swelling of the membrane lining the middle meatus. In many cases resection of the anterior portion of the middle turbinal will be found necessary before a probe may be passed into the sinus. At times even this procedure will not suffice as the anomalous position of some of the anterior ethmoidal cells will be found to so narrow or change the direction of the fronto-nasal duct that a probe will not pass. A malleable silver probe with blunt tip and three centimeters of the end curved at right angles, should be used. The handle of the probe should be bent downwards

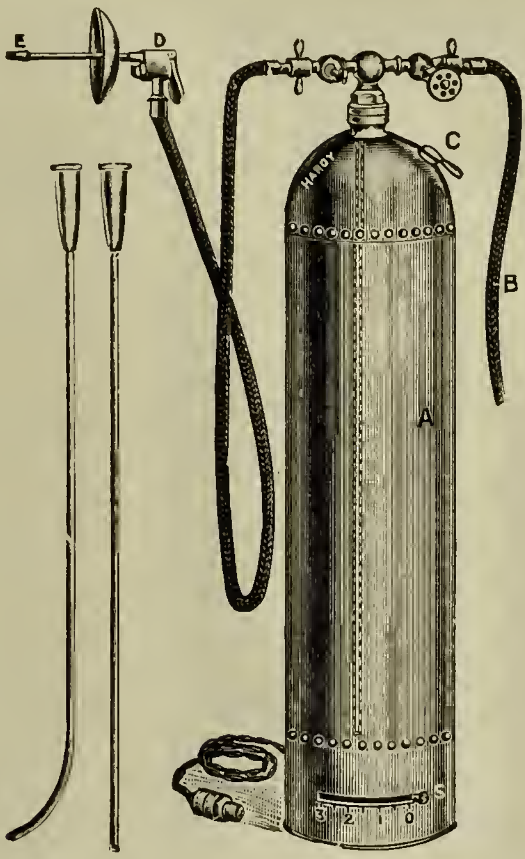


View Showing the Two Positions in Probing the Fronto-Nasal Duct.

f, s, Frontal sinus; o, e, Ethmoidal ostium; c, m, Middle turbinal; c, s, Superior turbinal; p, e, c, Posterior ethmoidal cell; sph, s, Sphenoidal sinus; a, Probe entering fronto-nasal duct; b, Probe within the frontal sinus.

out of the line of vision. The end curve of the probe should be varied to suit the necessities of the case.

After applying cocain to the anterior portion of the nose, the middle meatus and as far up as possible in the hiatus, the end of the probe is passed over the uncinate process and moved upward along the hiatus into the fronto-nasal duct. The handle may then be raised or lowered and the tip rotated in different directions in order to pass the irregularities of the duct and reach the sinus proper.



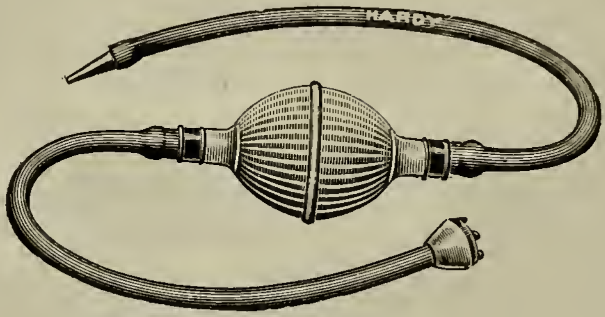
Author's Irrigating Apparatus and Cannulæ.

a, Tank; b, Compressed air inlet; c, Opening for filling and cleansing tank; d, Cut-off; e, Truncated cone tip to fit cannulæ; f, Electric heater.

Cases of empyema of the frontal sinus require immediate drainage. This may be accomplished by irrigating the cell with a curved cannula, by applications of cocain and suprarenalin to the middle turbinal and middle meatus, by resection of the anterior portion of the middle turbinal, one of the intranasal operations for enlarging the fronto-nasal duct, or by one of the various radical external operations. Drainage measures are especially indicated where ocular symptoms are present, when delay might mean permanent damage to the ocular apparatus, particularly the optic nerve.

When the pain of a frontal sinusitis is not relieved by shrinking the middle turbinal tissue with cocain and suprarenalin, a probe should be passed when possible and then a small silver cannula, bent to the same curve as the probe, should follow and the sinus should then be irrigated with a warm, sterile, physiologic, saline solution.

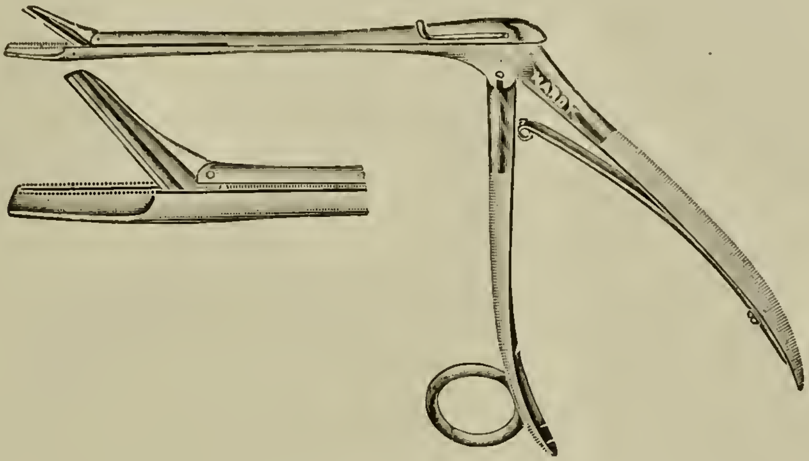
For irrigating the accessory sinuses the author has devised an irrigating apparatus consisting of a three gallon tank lined with block tin. Compressed air enters the tank above and forces the warm solution out through a long, block tin pipe, reaching nearly to the bottom of the tank. This tube connects at the top of the tank with a length of rubber tubing to which is attached a very heavy cut-off, such as is used for compressed air. A small tube four inches long with a truncated cone tip and a bell protector is brazed to the cut-off and forms the connection with the cannula. The force of the stream is thus under perfect control and any desired quantity of the solution may be used. The solution is sterilized and retained at the proper temperature by means of an electric stove set in the base of the tank.



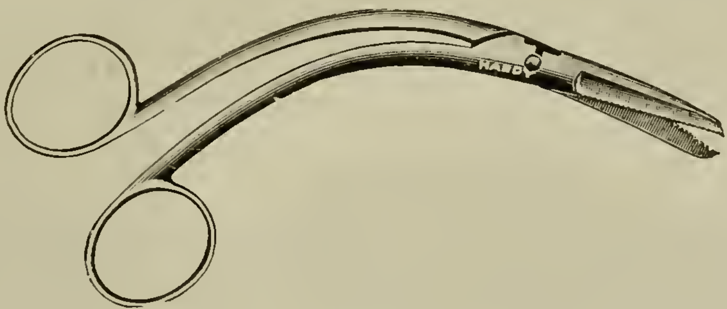
Double-valved Syringe.

After irrigation the sinus should be dried with a stream of compressed air through the cannula and argyrol 5 per cent., trikresol or other non-irritating antiseptic forced into the cell from the treatment bottle. It will usually be found necessary to resect the anterior third of the middle turbinal before the fronto-nasal duct can be reached with a cannula. This is in itself a great aid to proper drainage as the turbinal is always swollen and boggy under such conditions and acts as a constant obstruction to the outflow o pus. Ballenger (*Diseases of Nose, Throat and Ear,* 1909, p. 200) advocates the removal of obstructions to proper drainage in all cases of sinus infection. He has named the region of the hiatus semilunaris, the ethmoid cells and the recessus spheno-ethmoidalis the "vicious circle" of the nose. He also warns against intranasal operations preliminary to the radical external operations as tending to increase the virulence of the infecting organism.

[*Ophthalmic surgeon as rhinologist.* With the better understanding of the close relationship between ocular and nasal disease there has been developed a need for a better knowledge of nasal surgery on the part of the pure ophthalmologist. He may not feel competent to undertake these surgical measures, but at least he should be thoroughly familiar with the surgical anatomy of the nose and accessory sinuses. The ophthalmologist will be called in with increasing frequency as consultant in operations in this region, and will, of course, take part in the operations upon his own cases, which his increasing knowledge of the subject will lead him to refer to the nasal surgeon for operation.]



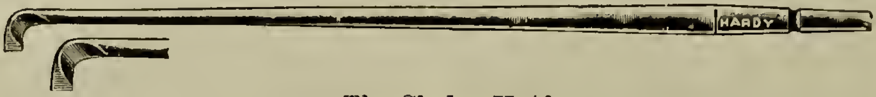
Van Struycken Nasal Punch Forceps.



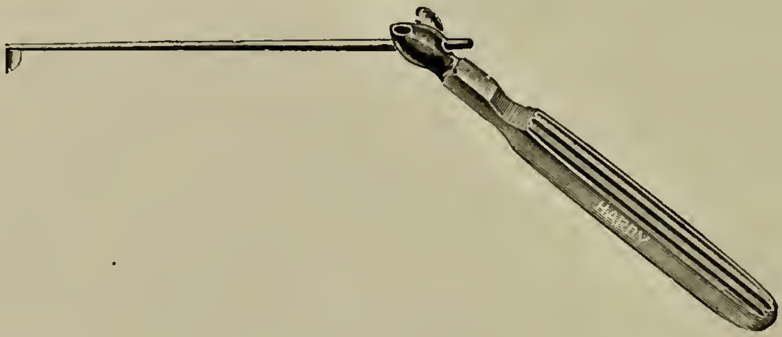
Casselberry's (serrated) Nasal Scissors.

In all nasal operating it is important to provide against excessive hemorrhage. Crile (*Trans. Acad. Ophthal. and Oto-Laryn.*, 1908) mentions experimental work showing that total anemia produces permanent changes in the central nervous system if maintained for seven minutes and total blindness results. If maintained for six minutes the blindness is only temporary.

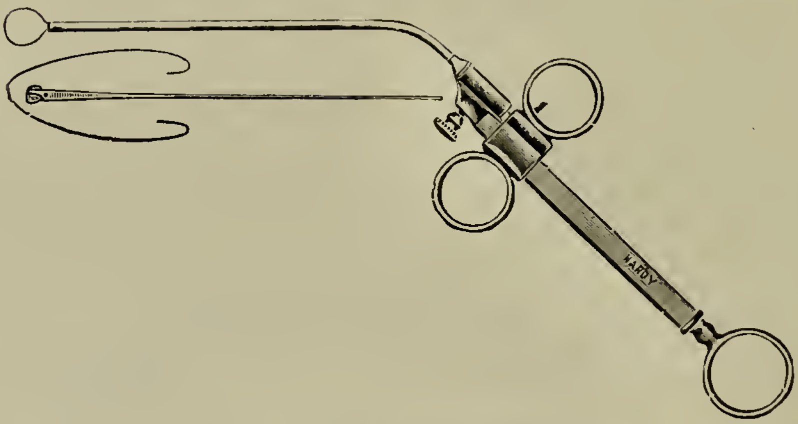
A 4 per cent. solution of cocain is applied by means of a cotton-tipped applicator to the anterior half of the middle turbinal, septum and middle meatus. Five minutes later suprarenalin in 1 to 1000 solution is applied, followed by a 10 per cent. cocain solution. In ten minutes anesthesia is usually complete.



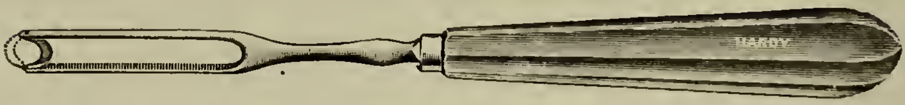
The Sluder Knife.



Lack's Knife.

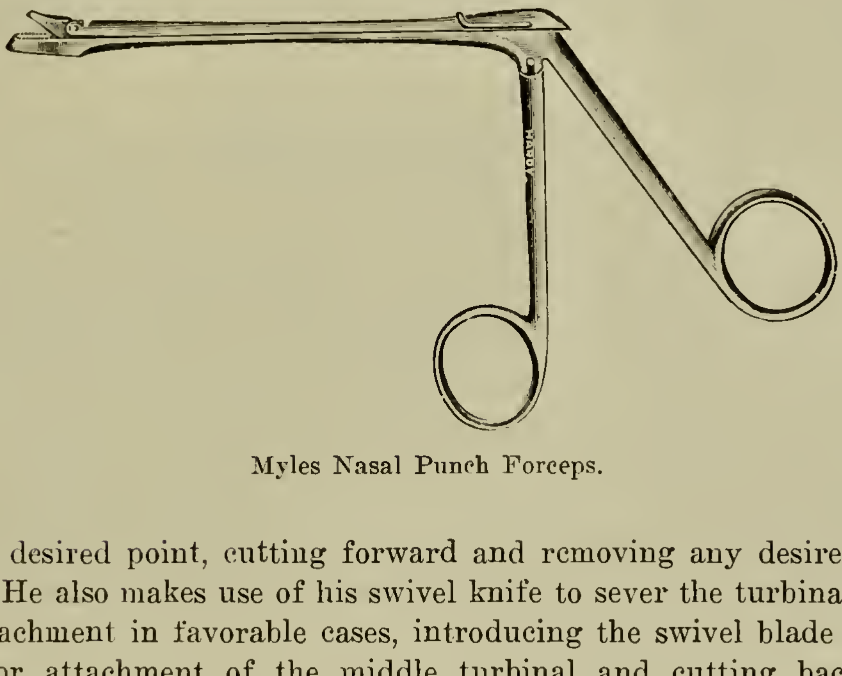


Krause Nasal Snare.



Ballenger Swivel Turbinotome.

In removing the anterior portion of the middle turbinal the anterior attachment is cut through by means of the Casselberry scissors, Van Struyken cutting forceps or by introducing the Sluder or similar angle knife into the middle meatus and cutting upward and toward the septum through the attachment. The latter method has the advantage that the incision is made under control of the eye, the various forceps, scissors, etc., requiring much space and interfering with vision during the operation. The final step consists in the removal of the cut segment of middle turbinal by introducing the bight of a snare, such as the Krause, into the incision and then pushing the loop downward and backward as far as it is desired to remove turbinal tissue. The snare is then closed and the turbinal cut through. The Holmes scissors, curved on the flat, are designed to cut away the necessary amount of middle turbinal without recourse to the snare. Ballenger (*Diseases of Nose, Throat and Ear,* 1909, p. 150) describes a turbinal knife with blunt end and curved cutting edge which he passes into the olfactory fissure and then turns toward the turbinal at the desired point, cutting forward and removing any desired portion. He also makes use of his swivel knife to sever the turbinal from its attachment in favorable cases, introducing the swivel blade at the anterior attachment of the middle turbinal and cutting backward with short strokes until the desired amount is removed. If a part only is to be cut away, the swivel blade is turned downward at the desired point and made to cut its way out below. All polypi and hypertrophies should be removed from the middle meatus when present as in chronic cases, using the Myles or Grünwald punch forceps or sharp curette. The frontal sinus probe should be passed into the sinus after the section of turbinal has been removed to insure the patency of the fronto-nasal duct. In some instances it may be necessary to cut away one or more of the ethmoid cells about the fronto-nasal duct before the probe can be passed into the sinus. This may be easily done by

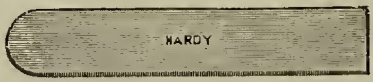


Myles Nasal Punch Forceps.

cutting through the cells with the Sluder knife and removing the débris with the Myles punch or a sharp curette.

In the great majority of acute frontal sinus infections, the above operative measures will be found sufficient, especially when supplemented by the vacuum pump which serves the double purpose of aiding drainage and producing a beneficial local hyperemia after the principle of Bier.

The after-treatment of operation, as with all operations upon the nose, is best performed in a hospital. The patient is prepared by administering forty grains of Merck's soluble lactate of calcium in five grain doses to insure proper coagulation of the blood. After the operation, packing of the nose is only exceptionally required, and thus the only disagreeable feature of nasal operation is avoided. The patient is at once put to bed and remains there until the following day. If necessary to operate in one's office, a Stevenson nasal tampon of gauze and compressed cotton may be used, as the disturbance of the homeward journey is likely to cause a hemorrhage. These tampons are kept in readiness for the hospital cases also and the interne instructed in the proper manner of applying them in case of necessity. The tampon may be covered by folding a piece of rubber tissue over it before insertion to prevent adhesion of the gauze outer layers to the wound.



Stevenson's (Bernay) Nasal Tampon (one-half size).

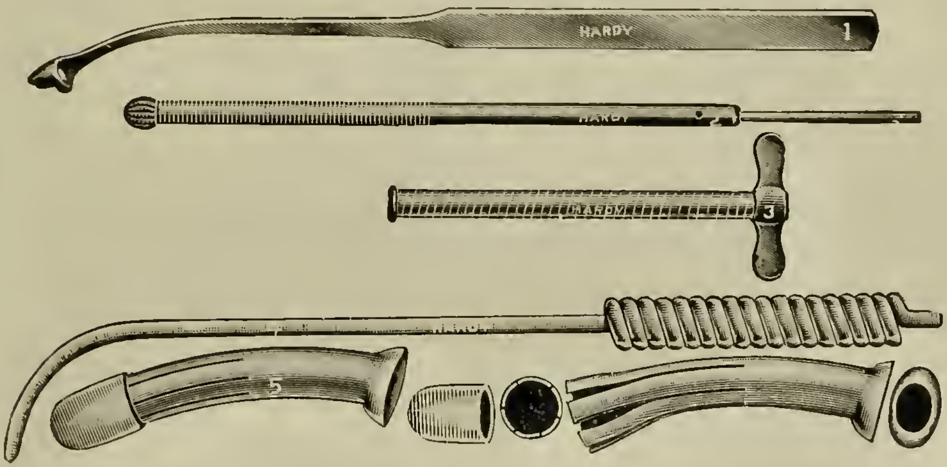
The patient may usually be allowed to leave the hospital in 24 or 36 hours and is then treated daily at the office by means of sterile physiological saline irrigations through a cannula passed into the sinus. Next, the sinus is dried by compressed air and 5 per cent. argyrol, 1 per cent. nargol, 0.5 per cent. trikresol, etc., may be injected into the cell and left there, the patient holding the head backward for a few minutes to insure the retention and distribution of the antiseptic.

Should the above measures fail to relieve the pain and especially the ocular symptoms, a larger communication between the nose and frontal sinus is indicated. This may be obtained by enlarging the fronto-nasal duct intranasally or by the simple trephine operation externally.

Ingals' operation. Probably the most ingenious operation for opening the frontal sinus intranasally is that devised by E. Fletcher Ingals

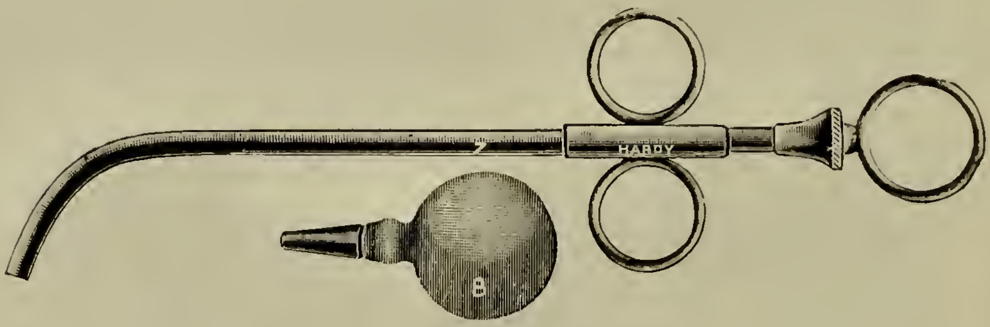
(*Jour. A. M. A.*, May 9, 1908). He first described the operation in 1904 and has since modified the technic somewhat. He believes that this procedure is the safest and best operation for the purpose in ninety-six per cent. to ninety-eight per cent. of all frontal sinus empyemas in spite of the anatomical irregularities and the danger of entering the cranial cavity. The necessary instruments are a pilot with detachable handle, pilot-burr, shield, packer, applicator, special pilot-burr and guard, and a self-retaining drainage tube.

Ingals studied fifty anatomical preparations and found two in which there was a possibility of injuring the internal table, one of these also showing the possible danger of cutting into the fossa ethmoidalis. As a safeguard a ligature is attached to the distal end of the spiral tube-shield and the burr is made to cut as far forward as possible. Röntgen photographs are necessary in each case to avoid anatomical dangers and to be sure that the pilot is in the fronto-nasal duct. Ingals has operated most of his cases in his office, but prefers the hospital as being safer. The anterior end of the middle turbinal is resected and polypi, deflections or other nasal obstructions are removed several weeks before the operation proper. Cocain is the usual anesthetic, but in exceptional cases ethyl chloride has been used and where given, after the probe has been passed and all is in readiness to complete the operation, its effect lasts a sufficient time for the purpose. Anesthesia is attained by passing into the frontal sinus a curved silver cannula attached to a syringe containing a 20 per cent. solution of cocain in 1 to 1000 suprarenalin solution. This is injected drop by drop and flows downward along the fronto-nasal duct around the cannula.

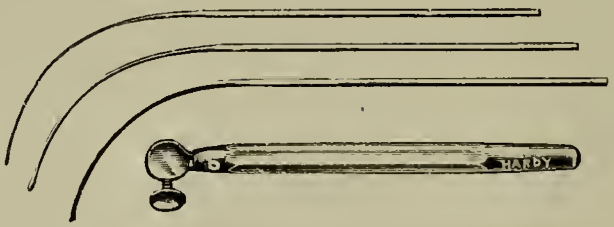


1. Modified Burr Carrier. 2. Modified Burr. 3. Flexible Spiral Sheath (Ingals). 4. Drainage Tube Introducer. 5. Gold Drainage Tube (Ingals).

The operation is given in Ingals' own words as the best expression of his meaning. "Before beginning the operation all instruments are sterilized, the spiral tube shield is slipped over the burr, and the burr attached to the chuck of a dental engine. The spring ends of the drainage tube are bent back so as to make its open end about a centimeter in diameter, and then they are gently pressed together and enclosed in a No. 2 gelatin capsule. This is then dipped into melted paraffin, melting at about 110 degrees, whereby it is covered by a thin film that will prevent it from dissolving in the fluids in the nose for about five minutes after its introduction. Unless covered in this way, the capsule would soften in about twenty seconds, which would not be quite time enough for the introduction of the tube.



Gauze Packer. Bulb for Medication through Gold Drainage Tube (Ingals).



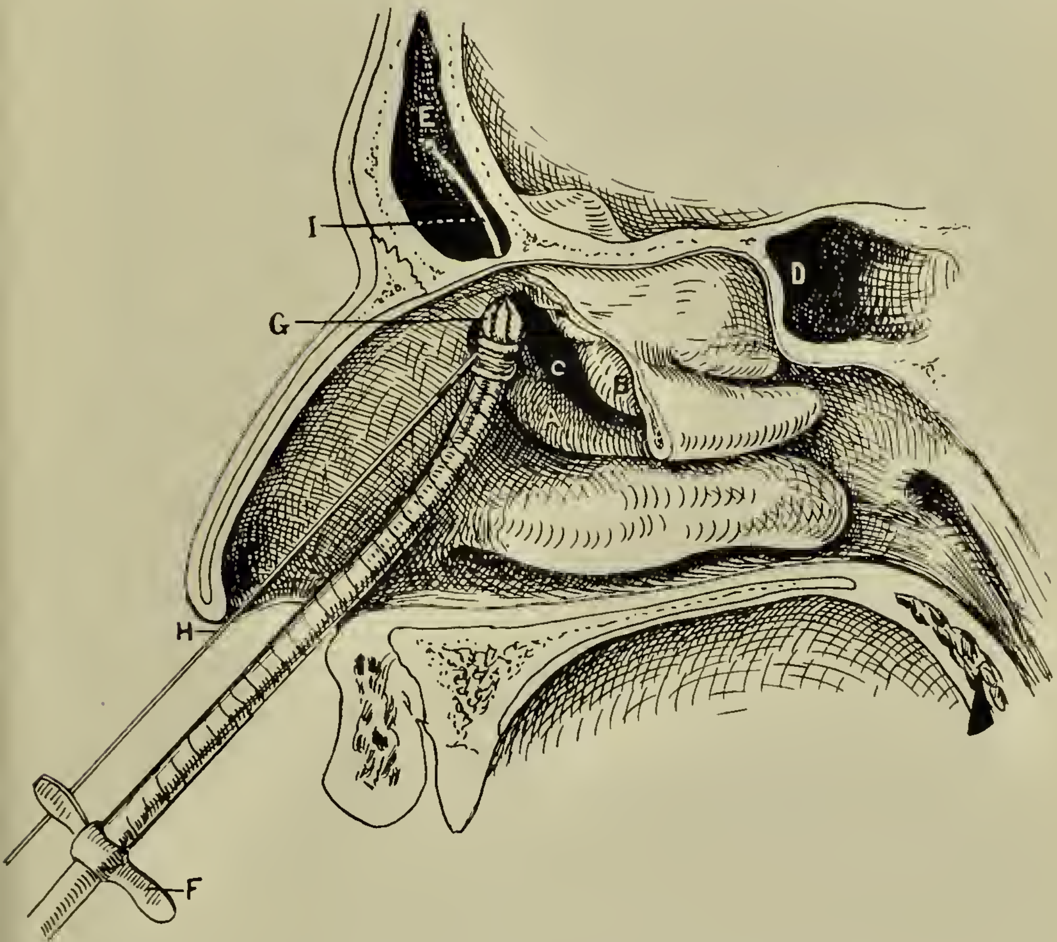
Frontal Sinus Probes and Handle (Ingals).

"As soon as the patient is properly anesthetized, and the pilot probe introduced, the handle is removed from the pilot (or probe), the hollow burr is slipped on over it and carried up to the lower orifice of the naso-frontal duct, the shield being pushed up with it so that the mucous membrane of the naris will not be injured by the rapid revolutions of the flexible cable.

"The electric current is now turned on, and the burr is gently pressed upward. It usually cuts its way into the frontal sinus in two or three seconds. I usually draw it back and pass it up again two or three times to make sure that the canal is perfectly free, then withdraw it and the pilot.

"The patient must now be cautioned not to blow the nose for three or four days because of the danger of causing emphysema about the eyelids, as in other cases where the ethmoid cells have been opened.

"If it has been necessary to use a pilot with more than the normal curve, one with the normal curve is now introduced, and the burr is passed in again to insure a proper curve of the canal to fit the gold drainage tube. The naris should next be mopped thoroughly with vaselin on a swab of cotton. The packer is then introduced well into the enlarged canal, and through it the frontal sinus is packed with a strip of one-inch sterile gauze saturated with a 20 per cent. solution of chlorid of zinc. This is allowed to remain about five minutes. The packer is then drawn out about a centimeter so as to bring its end as nearly as possible to the lower end of the enlarged canal, and the gauze is then withdrawn, through it, thus cauterizing the whole length



Ingals' Intranasal Frontal Sinus Operation.

of the wound but avoiding any cauterization of the mucous lining of the naris.

"The spiral tube shield is next passed over the stem of the applicator and then the gold drainage tube is slipped on the end of the instrument and introduced into the enlarged drainage canal. The spiral tube shield is pushed up against the lower end of the gold tube to hold it in position, the applicator is withdrawn and the operation is finished.

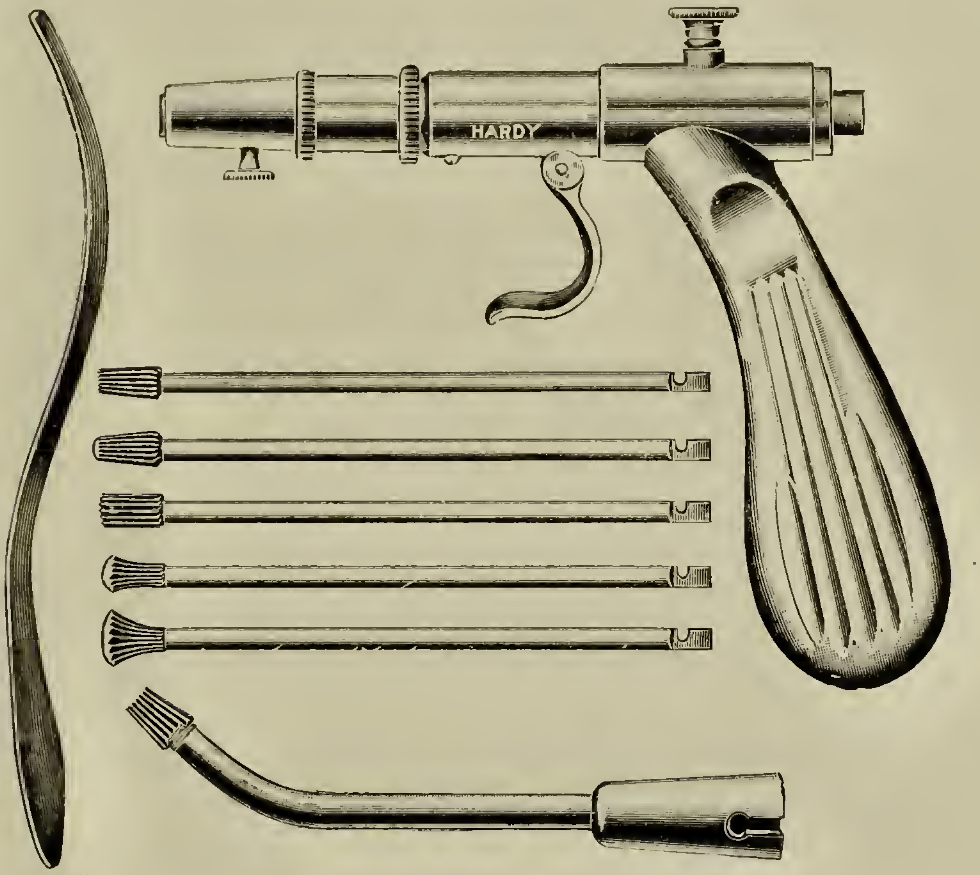
"If the drainage tube does not pass in easily it must result either from the burr not having been carried into the frontal sinus or else from the pilot having had a curve different from the normal. In either case the tube should be withdrawn and the burr passed in again over a pilot of normal curve. I have sometimes packed the naris afterward with gauze to prevent possible bleeding, but I do not think this necessary, and it is objectionable if not needed. I have in no case seen bleeding of more than an ounce of blood during or following the operation, and usually there are not more than two or three drams."

The after-treatment consists in the use of cleansing solutions such as physiological saline solution and the injection of 10 per cent. to 20 per cent. argyrol through a silver catheter into the sinus where the secretion continues. Ingals' experience has been that the size of the canal resulting from this operation is ample for almost all cases of frontal sinus suppuration and proves that curettement is usually unnecessary. Acute infections may occur in the sinus after this operation during the course of an acute rhinitis but the adequate drainage rapidly results in healing and such attacks are no more to be charged to the operation than an acute attack in a normal sinus.

The advantages of the intranasal operations are many. The deforming scar of the external operation and the longer period of after-treatment incapacitating the patient are avoided. A general anesthetic is usually unnecessary and should it be necessary in special cases to operate externally an important part of the external operation has already been accomplished. Ballenger's (*Diseases of Nose, Throat and Ear,* 1909, p. 203) experience in more than four hundred cases corroborates that of Ingals in that few cases of frontal or ethmoidal sinusitis require more radical interference than a proper intranasal operation. This seems to be the general opinion at the present time and doubtless will receive wider recognition as these accessory sinus infections are recognized and properly treated in the early stages.

Halle's operation. Halle was the first to devise a method of cutting away the heavy spina nasofrontalis of the superior maxilla by means of electrically driven burrs and drills thus obtaining a wide communication between the nose and frontal sinus.

As in all intranasal operations for drainage of the frontal sinus, Halle considers his method suitable for all but the most severe cases with meningitis, fistulæ or orbital complications. Local anesthesia is sufficient and may be induced after Ingals' method as described above.

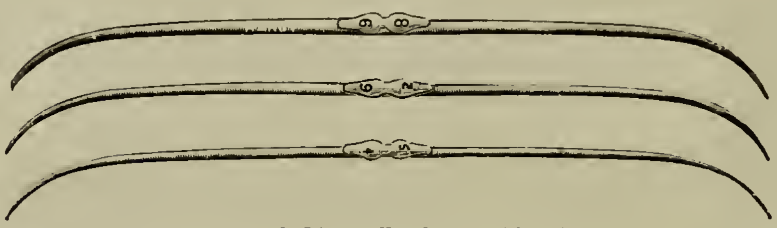


Instruments for the Intranasal Frontal Sinus Operation (Halle).

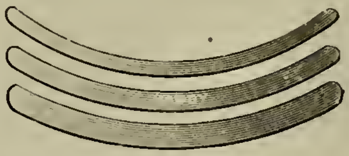
The first step is the passing of a probe into the frontal sinus. Next, the protector is passed into the sinus beside the probe.

The sharp-pointed drill is now engaged against the lower posterior border of the spina nasofrontalis and made to cut upward and forward. Only sufficient bone is removed with the sharp drill to allow the introduction of the blunt drill. This in turn cuts away enough bone to make room for the pear-shaped and bulbous-end drills which complete the removal of the frontal sinus floor, the protector and the blunt ends of the drills effectually preventing injury to the tabula interna. The extent of the operation is controlled by the finger held at the inner orbital angle. The sinus may now be curetted if necessary and packed with iodoform gauze. Granulations are controlled by silver nitrate, trichloracetic acid or alcohol, and Halle trains his patients to pass a large cannula frequently to maintain the opening.

Good's operation. R. H. Good (*Jour. A. M. A.*, Aug. 31, '07, pp. 753-754) proposes to reach the frontal sinus intranasally by means of specially made chisels and a curved rasp. The middle turbinal is removed after proper anesthesia has been obtained with cocain crystals and adrenalin 1 to 1000. The larger chisel is then used to cut away the processus uncinatus. The frontal sinus duct is then located and 10 per cent. cocain in adrenalin 1 to 1000 is injected into the frontal sinus with a syringe and properly curved cannula. The protectors are of three sizes and the largest possible is inserted into the sinus. The larger chisel is now used to cut away the frontal process of the superior maxillary bone, the spina of the frontal bone and the anterior medial wall of the ethmoid. The removal of these structures is facilitated by forceps and curettes. The protectors are of brass and pliable on the flat. They serve to prevent wounding of the internal table of the skull. The chisel edges are dull and tapering to avoid cutting into the os planum of the ethmoid. At this point the narrow rasp which is curved so as to enter the sinus easily, is introduced. The sharp teeth are on the concave surface while the convex surface is perfectly smooth. If the rasp will not enter the sinus the smaller chisel is used to enlarge the opening. Good keeps a prepared skull before him in operating, the better to judge of the possibility of entering the orbit or injuring the lacrimal bone. A finger in the orbit controls the rasp which is used to cut away the spina frontalis and fronto-ethmoidal cells. The rasp should be made to cut forward and

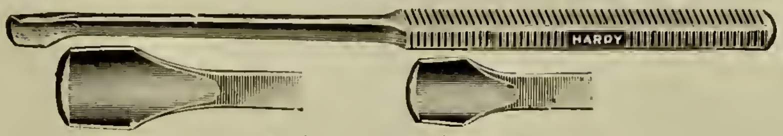


Frontal Sinus Probes. (Good.)



Frontal Sinus Protectors (one-half size). (Good.)

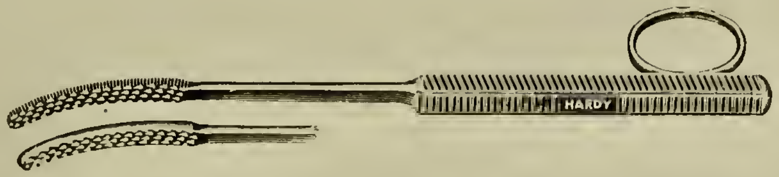
outward, not directly forward, and care should be taken not to withdraw the rasp so far as to injure the septum, which would result in troublesome adhesions. The sinus may be curetted with flexible curettes and packed with gauze saturated with carbolized petrolatum. This packing is removed in 24 hours and no treatment used except the application of silver nitrate to profuse granulations.



Frontal Sinus Chisels. (Good.)

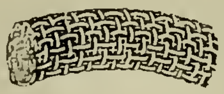
This operation has the advantage of simplicity over those of Halle and Ingals, which require a much more expensive equipment both in the first cost and in maintenance.

The external operation upon the frontal sinus is indicated in those cases which have not improved after intranasal drainage or where it has been impossible to pass the guiding probe into the sinus. In this class also are the severe types, especially the streptococcic and pneumococcic infections which rapidly destroy tissue, and the cases with cranial or orbital involvement or where fistulæ are present.



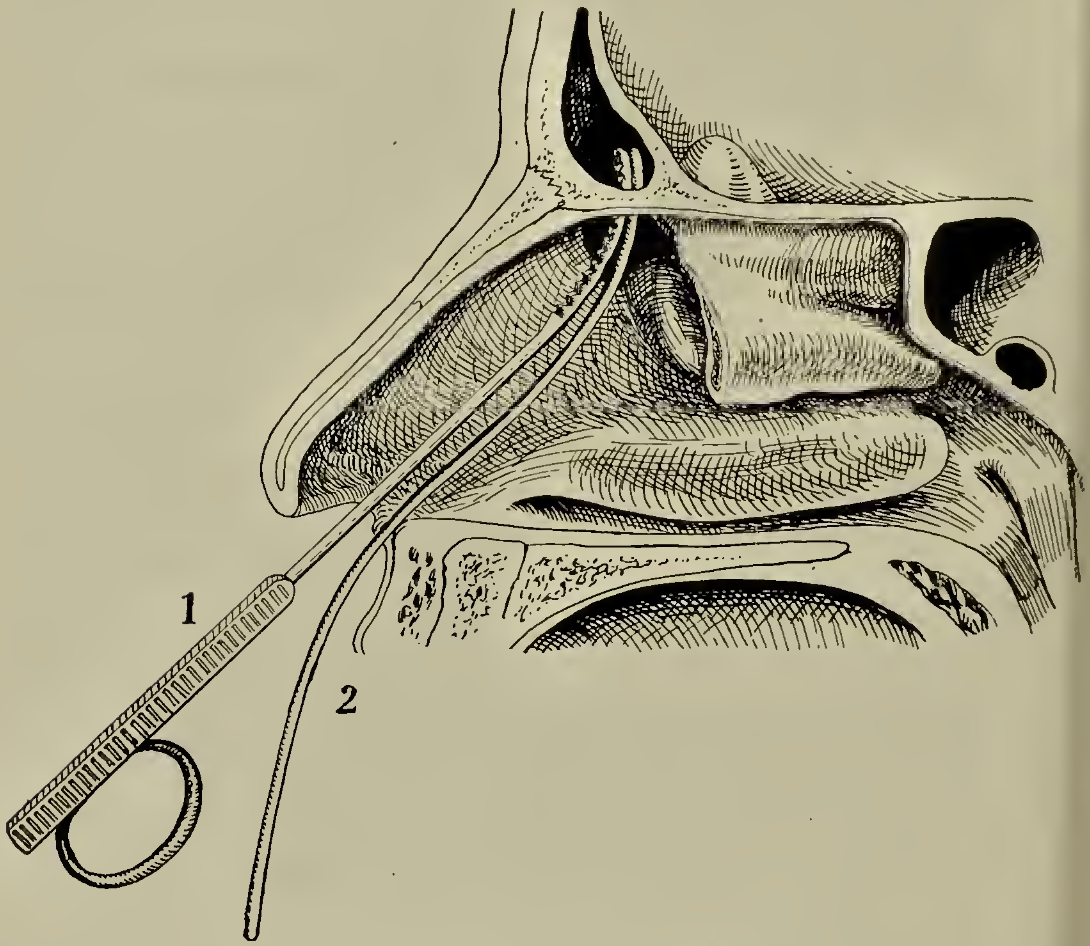
Frontal Sinus Rasps, Right and Left. (Good.)

The earliest frontal sinus operation was the simple opening of the cell over its most prominent point and was performed only in cases of perforation of the sinus wall or when swelling over the sinus area indicated abscess or new growth. Steiner (Entwicklung der Stirnhöhlen. *Archiv. f. Klin. Chirurgie* XIII) has gathered some of the earliest literature on this subject. He mentions the method of Riberis who secured drainage by cutting a large opening in the lamina papyracea. In the same monograph he credits Runge with the idea of first producing complete obliteration of the frontal sinus. Ogston in 1884 (*Med. Chronicle,* 1884, Vol. 1, No. 3, p. 237) states that he had



Frontal Sinus Drain. (Good.)

never been able to locate the fronto-nasal duct in the nose and so recommended trephining externally. His incision was a single vertical one from the root of the nose in the median line. After elevating the skin and periosteum he cut through the bone at the most prominent point with a trephine having the diameter of a sixpence (about 1.5 cm.). He curetted the lining membrane and forced a trocar through the naso-frontal duct for drainage, leaving in place a drainage tube. In simple trephining of the frontal sinus Kuhnt (*Uber die Entzündlichen Erkrankungen der Stirnhöhlen,* Wiesbaden 1895) enters at a point found by drawing an imaginary line passing through the supraorbital notches and a second line from the anterior crista lacrimalis, perpendicular to the first, the point of entrance being at their crossing. Mallet and chisel, or electric trephine, may be used. This method is used only in acute cases and for diagnosis. The radical operation is at once undertaken where extensive disease is found.



The Good Intranasal Frontal Sinus Operation.
1, Frontal Sinus Rasp; 2, Protector.

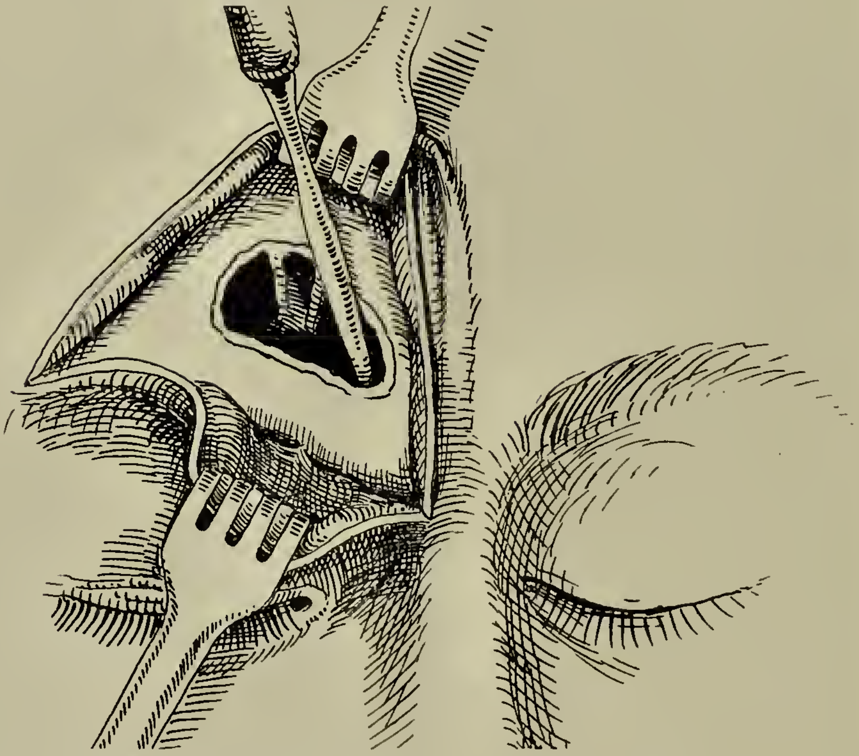
Even at as late a period as 1887 the indications for opening the frontal sinus were intracranial pressure, dilatation of the cell walls or dislocation of the eyeball.

The more recent operations upon the frontal sinus are divided by Hajek into three classes. In the first class are grouped those operations in which the whole or a part of the anterior sinus wall is removed. The second class is represented by the Jansen operation for removing the floor of the sinus and the third class includes those methods in which both the anterior and inferior walls of the sinus are removed.

In all operations upon the frontal sinus and orbit, according to Czermak and Elschnig, the anatomical points to avoid are the supraorbital and infraorbital branches of the fifth nerve, nervus frontalis, optic nerve, and third, fourth and sixth nerves in the fissura orbitalis superior and inferior. The attachments of the ocular muscles about the foramen opticum, the pulley of the superior oblique and the inferior oblique attachment are also danger points as well as the fascia supporting the lacrimal gland, the internal palpebral ligament forming the lid attachment to the orbital margin at the inner canthus, the lacrimal sac and duct. (Czermak and Elschnig, *Augenärzt. Operationen,* Vol. 1).

Onodi (*Archiv. f. Laryng. u. Rhinolog.* Bd. 27, Heft 1, S. 126) in examining many specimens showing the anatomical relations of the frontal sinus, has observed that in those where the septum interfrontale was displaced from the median line the olfactory groove presents a prominence on the posterior wall. Between this prominence and the septum is thus formed a depression termed by Onodi the recessus crista galli. The bone forming this prominence is very thin and projects forward from the posterior wall a distance of from 7 to 11 mm. It forms a point of great danger during the radical frontal sinus operation as was first pointed out by Boeninghaus (*Handbuch der Chirurgie des Ohres u. der oberenluftwege,* 1911, Bd. 3) who has named this anomaly the "dangerous frontal bone." The thin bone in this region is likewise dangerous as a route by which diseases of the frontal sinus may extend to the meninges. The frontal sinus walls should always be removed with care to avoid fracturing the bone in the dangerous region near the crista galli; at least one case of operation upon the frontal sinus, that reported by Heine (*Monatsschr. f. Ohrenheilk.* 1906. S. 568) resulted fatally owing to a fracture of the crista galli and a tear in the dura. This region had not been directly reached by the operation but had been injured by the blows of the chisel in removing the anterior frontal sinus wall.

Operation of Nebinger-Praun. (Die Stirnhöhleneiterung, *Dissertation,* Erlangen, 1890). The incision is made along the orbital margin from the naso-frontal suture to the supraorbital notch and the skin and periosteum elevated from the anterior sinus wall, the latter procedure being facilitated by a vertical incision about 4 cm. long, in line with the frontal vein. The anterior wall is then removed with chisels, the cell cleansed and curetted and the naso-frontal duct enlarged and drainage left at the juncture of the vertical and horizontal incisions.



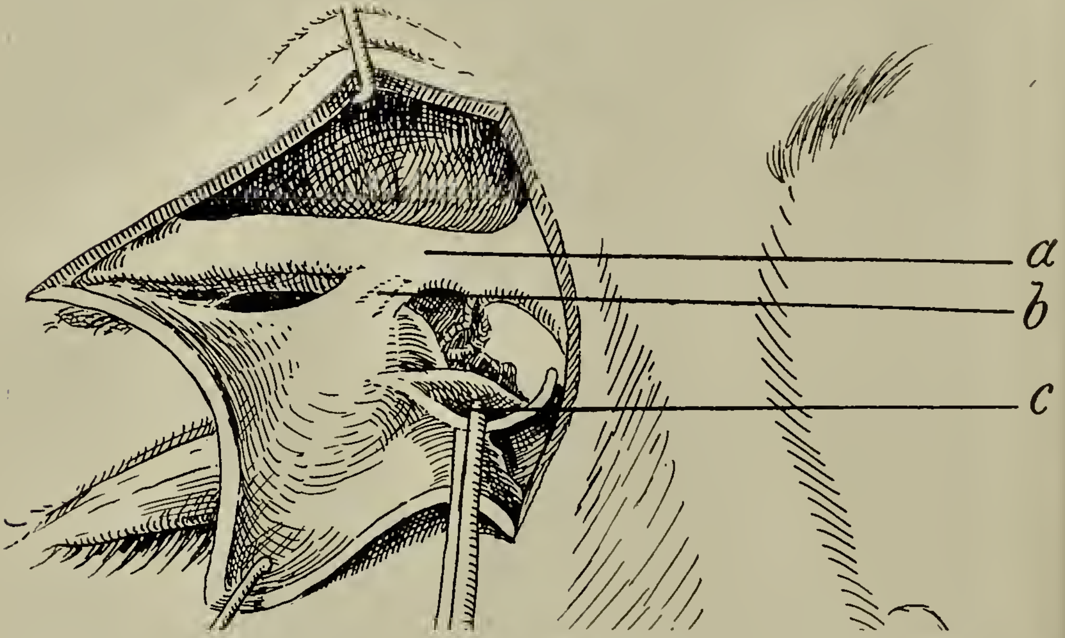
The Hajek-Luc Radical Frontal Sinus Operation.

Operation of Hajek-Luc. (Contribution a 1 etude des suppurations du sinus frontal, *Arch. international de Laryngol.,* Bd. VII, No. 27). This operation is also known as the Ogston-Luc method. The incision is made along the brow which has been sterilized but not shaved and extends usually from the temporal end of the brow to the root of the nose. A second vertical incision begins at the median end of the horizontal incision and extends upward as far as the upper limits of the sinus. The skin and periosteum are now elevated, leaving a triangular area of bone exposed. The sinus is now entered with the chisel slightly to the outer side of the median line and a part of the anterior wall cut away. Diseased membrane and bony septa are removed and the fronto-nasal duct enlarged by cutting away part of the anterior ethmoidal cells. Originally Luc used a rubber tube drain into the nose, but later iodoform gauze was employed, the external wound being immediately closed. Ballenger recommends leaving the rubber tube in position for several weeks or until all discharge ceases. There is less disfigurement in this operation than in the more radical procedures, but the liability to relapse due to insufficient removal of diseased tissue is a disadvantage.

Operation of Kuhnt. Kuhnt, (Ueber die Entzündlichen Erkrankungen der Stirnhöhlen u. s. w. Wiesbaden 1895) advocates the removal of the entire anterior wall of the frontal sinus with all of the lining membrane. The incision begins at the median end of the eye-brow and extends to its outer third. A second incision begins at the median end of the first and extends directly upward to the upper limit of the sinus. The entire anterior wall, together with all bony septa within the sinus is now cut away with chisel and bone forceps and the bone edges smoothed. The entire lining membrane, including that of the upper part of the nasal duct, is now removed and the wound sutured, space being left for a large drainage tube. The fronto-nasal duct closes by granulation and prevents re-infection from the nose. Cure results in almost every case, but great disfigurement follows and the anterior ethmoidal cells which are always coincidentally involved are not removed.

To avoid these disadvantages the Kuhnt and the Hajek-Luc operations may be combined. In this operation the entire anterior wall is removed, the anterior ethmoidal cells are opened and the rubber tube gives drainage into the nose, the external wound closing primarily. Burchardt (*Archiv. f. Laryn.* 1904, Bd. 15, p. 495) modifies the Kuhnt operation for chronic frontal sinusitis as follows: After the entire anterior wall of the sinus has been removed down to a narrow strip at the supraorbital margin, all pus, granulations, necrotic bone, bony partitions and irregularities are removed, the fronto-nasal duct is enlarged and a large drainage tube passed through it into the nose. The entire external wound is then closed. In 4 to 5 days the tube is removed and when the wound has healed externally a pressure bandage is applied to bring about healing between the skin and periosteum of the anterior wall and that of the posterior wall. The reaction is less and the long continued packing is avoided. In closing the wound the periosteum is carefully sutured with the skin to cover the bone surface left, insuring a slight scar. The best results are in shallow sinuses. Less time in operating is required and quite as thorough a result is attained as in Killian's operation.

Operation of Jansen. Jansen (Fraenkel's *Archiv. f. Laryng.*, Bd. 11, 1894) makes a curved incision from the outer orbital margin below and parallel to the eyebrow and extending to the root of the nose. The periosteum of the roof of the orbit is now detached and the bony floor of the frontal sinus cut away. The lining membrane of the sinus is curetted and all diseased tissue removed. This route allows of thorough removal of the infected ethmoid cells but has the disadvantage of less thorough exenteration of the frontal sinus itself.



The Killian Radical Frontal Sinus Operation, Showing the Bridge, a; Flap of nasal mucous membrane, b; and trochlea attached, c. (After Czermak and Elschnig.)

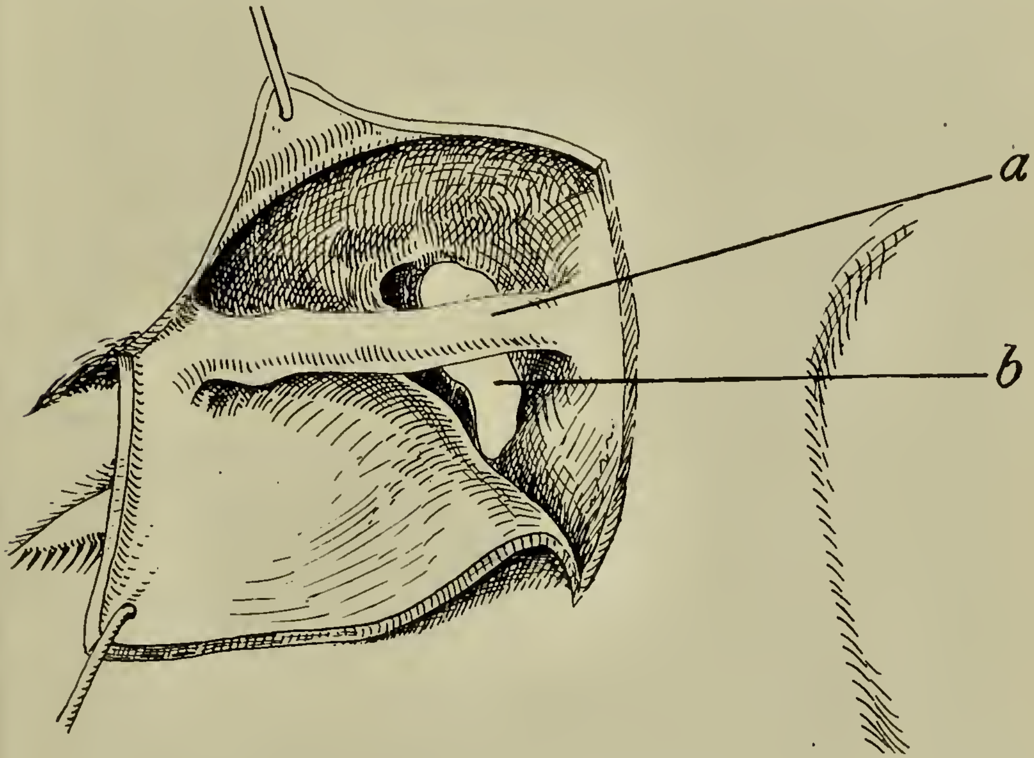
Operation of Killian. Killian (*Archiv. f. Laryng. u. Rhinol.* Bd. XIII, Heft 1, S. 84) was the first to propose the idea of leaving a bridge of bone, periosteum and skin at the orbital margin to preserve the contour of the brow. At first he was dissatisfied with the solid bridge and attempted to resect it at either end, replacing it at the close of the operation. The case in which this was tried, however, showed downward displacement of the bridge when inspected a year later.

After various changes Killian gives the following as his improved technic. The patient undergoes a thorough general examination before operation. Before the operation is begun the patient receives hypodermically gm. 0.01 of morphine and all sinuses which contain pus are irrigated and the nasal chamber cleansed. Next a tampon is introduced into the posterior portion of the naris, especially the middle meatus. A general anesthetic is now given and the field of operation sterilized. The eyebrow is not shaved. The skin incision begins at the temporal end of the eyebrow and is continued through the brow to its median end when it is made to curve downward along the side of the nose at the middle of the frontal process of the superior maxilla. The periosteal incision is made in two parts. The first is made parallel to the orbital margin and 5 or 6 mm. above it, and of the same extent as the horizontal portion of the skin incision. The second incision begins near the pulley of the superior oblique muscle, 5 to 6 mm. below the first periosteal incision, and curves downward following the skin incision along the middle line of the nasal process of the superior maxilla. The frontal sinus is now opened either above or below the bridge of bone thus outlined. After the chisel has cut away sufficient bone a probe is used to outline the extent of the cavity, the probe passing between the lining membrane and the bony wall. This avoids opening the membranous sinus early in the operation, exposing the wound to infection. The periosteum is now elevated over the entire extent of the sinus, the soft tissues are retracted upward and a furrow is cut along the line of the upper periosteal incision with a chisel. Next, the entire anterior wall is removed with chisel and bone forceps and all septa cut away. The lining membrane is now removed thoroughly with curettes, not forgetting the inner surface of the bridge. The operator next stands behind the patient's head and with an electric headlight to illuminate the sinus, a chisel is used to remove the floor along the line of the lower periosteal incision. The entire floor may now be removed with a curved bone forceps. The periosteum is now elevated from the lower incision to the margin of the nasal bone and from the lower orbital border, lacrimal sac and orbital roof. The frontal process of the superior maxillary bone is then removed with chisel and bone forceps. The nasal mucous membrane is carefully preserved. This makes possible the removal of the orbital roof in the deeper portions, together with temporal and ethmoidal projections of the sinus. The nasal membrane may now be detached from the frontal process and the frontal cells of the ethmoid removed with the Hartmann punch, and a sharp curette. A smooth walled space is thus formed between the nose and the frontal sinus. The anterior end of the middle turbinal may now be removed after first removing the tampon from the middle meatus and, if necessary, the ethmoidal cells and their lamellæ may be cut away and the sphenoidal sinus reached. A flap may now be made by incising the nasal membrane at the margin of the nasal bone, carrying the incision upward, backward and then downward and laying the flap outward to cover the wall of the enlarged nasal duct, leaving a large, permanent opening. The field is then freed of debris and flushed with sterile physiological saline solution. Iodoform powder is blown into the sinus and a perforated rubber tube drain is inserted reaching from the temporal wound angle to the nasal entrance. It is held in position, together with the mucous membrane flap, by gauze packed from the nose. The external wound is accurately closed and lightly covered with gauze and bandaged. The patient is put to bed on the well side and instructed not to blow his nose, but to remove the secretion by hawking it backwards into the throat. The wound is dressed daily, the nasal tampon is removed on the second day, the drainage tube on the third or fourth day and the sutures on the fourth or fifth day. A protective dressing leaving the eye uncovered is continued for a short time longer. No nasal irrigation is allowed; 2.5 per cent. silver nitrate may be applied to the sinus walls through the nose to keep down exuberant granulations.

V. Eicken (*Annals of Otol.,* Mar. 1909), who has been first assistant in Killian's clinic during all his work on his radical frontal sinus operation, recently reported 100 cases observed from 1902 to 1907. He expressed great faith in Bruening's headlight as a wonderful aid in relieving the pain, especially in acute sinusitis. He notes one hemorrhage into the orbital tissues from operation which absorbed without any symptoms. Diplopia occurred rarely and in no case was it permanent. Following three deaths after the Killian operation a complete diagnosis of the condition of all sinuses is now made and the antrum operated before the radical frontal. Especially is the sphenoid investigated so that when needed it may be opened at the time of operation. His statistics include three fatal cases, seven uncured, sixteen improved and sixty-nine cured. By cured he means those cases which have no more pain, suppuration or polypi formation.

Hajek (*Zeitschrift f. Augen.,* June 1907, S. 569) modifies the Killian operation as follows: He does not attempt to save the nasal mucous membrane after the removal of the processus nasalis as he considers it unnecessary and difficult. The removal of the orbital floor is made much easier by separating the orbital periosteum and retracting the soft tissues instead of leaving the trochlear attachment. He has never seen any injury to the superior oblique muscle, nor has an ophthalmologist been able to locate any interference with its function in the seven cases which he has operated even as early as eight days following operation. The approach to the anterior ethmoid cells is also facilitated by removing the trochlear attachment.

Richards (*Trans. Amer. Laryn. Assn.*, 1905), in all cases of frontal sinus suppuration, associated with ethmoidal or other sinus infection accompanied by polypi, advocates the removal of the anterior frontal sinus wall below the supraorbital ridge, with as much of the floor and nasal process of the superior maxillary bone as seems necessary to gain access to the sinus. Obliteration of the sinus follows and is attained by prolonged packing. The process is disagreeable and requires prolonged after-treatment, but is, according to Richards, reasonably certain to effect a cure.



The Hajek Modified Killian Radical Frontal Sinus Operation, Showing the bridge, a; with trochlea detached and opening through the ethmoidal cells, b. (After Czermak and Elschnig.)

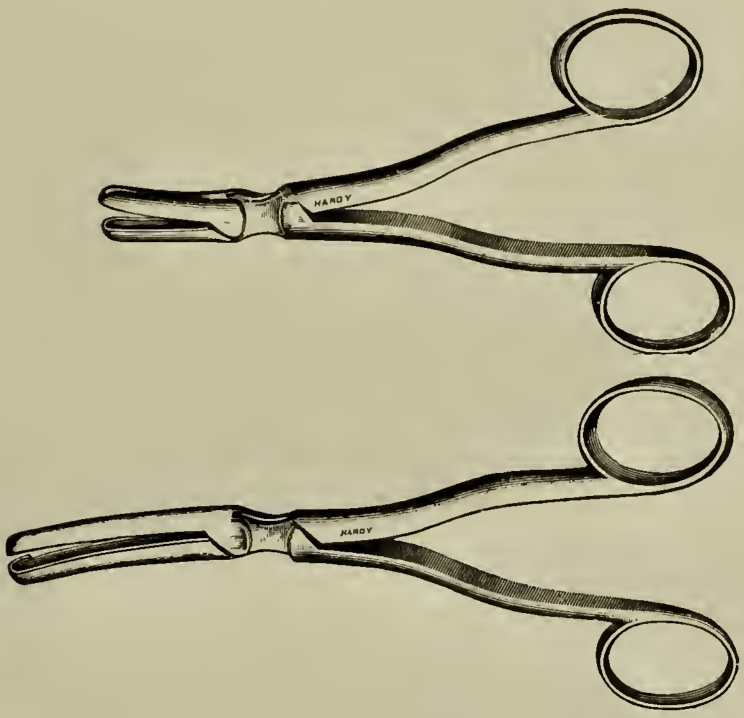
Coakley removes the anterior sinus wall above the supraorbital ridge, obliterates the frontal-nasal duct and then the sinus by packing.

Lathrop, quoted by Richards, suggests a modification of the Ogston-Luc operation. A short incision is made below the inner end of the eyebrow and the sinus opened at this point. The nasal portion of the frontal sinus floor is removed by curettes with all of the ethmoidal cells about the ostium frontale. The anterior sinus wall is not disturbed.

Coffin (*Trans. Amer. Laryn. Assn.*, 1905) uses the open method where the frontal sinus is alone involved and occasionally where the ethmoids are also infected. Gauze pack is used through a small opening in the anterior sinus wall and continued until sinus obliterates. The opening is enlarged if needed to reach all parts of a large sinus and if necessary the nasal process of the superior maxillary bone is removed as in the Killian operation to reach ethmoid labyrinth.

Citelli (*Zeitschrift f. Laryn., Rhin.*, Bd. 11-Heft. 4, 1909, p. 339), after animal experiments and a trial of his method in two cases, proposes to operate for chronic frontal sinusitis by removing enough of the anterior wall of the frontal sinus to reach all parts of the cell. An open wound is left and treatment continued with curettage, cautery, etc., to promote healing and especially closure of the frontonasal duct. Then for several days the sinus is cleansed with hydrogen peroxide and formalin 1 to 300 and dusted with iodoform powder. The cell is then filled with melted paraffin saturated with iodoform. This stimulates connective tissue formation in the lining membrane and is in time itself absorbed and not encapsulated as might be expected. Citelli claims that the cosmetic result is a great improvement.

Prince (*Trans. Section Laryng., A. M. A.*, 1908) proposes a radical frontal sinus operation which while thorough gives a good cosmetic result. He first introduces a post-nasal plug. If a considerable septal deflection is present he corrects it and removes the anterior end of the middle turbinal with his forceps. These forceps are also used to remove the ethmoidal cells where polypi are present. After clipping the eyebrow and proper cleansing of the region with soap and antiseptics, a skin incision is made beginning at the junction of the frontal, nasal and maxillary bones and extending along the middle of the eyebrow. He does not extend the incision downward along the side of the nose on account of the objectionable scar resulting. The incision through the periosteum parallels the skin incision. The periosteum is now elevated from the roof and inner orbital wall, the trochlea being carefully detached with the periosteum. The orbital contents are retracted and an opening made in the frontal sinus with a rounded chisel. Prince's modified Kerrison rongeur is now used to remove the anterior portion of the frontal sinus floor. Where the nasal process of the superior maxilla obscures the ethmoid cells, as much as necessary is removed and the os planum is removed as far back as the anterior ethmoidal foramen. Forward biting forceps now remove the remainder of the frontal sinus floor. The middle turbinal forceps are now passed into the nose and with the finger for a guide a free opening is made through what remains of the ethmoid cells up to the frontal sinus. The rongeur removes the internal naso-frontal spine through the nose. The septa in the frontal sinus are removed and the mucous membrane thoroughly curetted with a special burr. Diseased areas of the sinus membrane are cauterized with pure phenol or trichloracetic acid. Prince views the cavity through a sinuscope having an electric lamp placed on the side of the instrument. Where necessary the ethmoidal cells may be removed and the sphenoidal sinus opened through the nose as the previous operative work has afforded plenty of room. The cut edges of the periosteum are united with pyoktanin catgut, especial care being given to replacement of the trochlea. The skin wound is sutured carefully with horsehair and sealed with collodion on a strip of gauze. The after-treatment is slight, consisting in wiping out the cavity with cotton saturated with 25 per cent. alcohol. The patient must not blow his nose but is instructed to aspirate the secretions into the naso-pharynx.

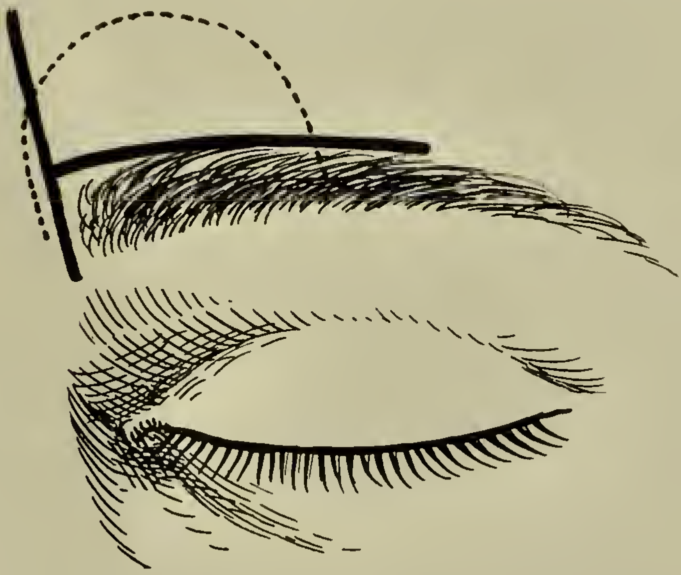


Prince's Turbinal Forceps.

Knapp (*Sec. Oph. A. M. A.*, 1908) has modified existing operations for dealing with orbital subperiosteal abscesses secondary to nasal accessory sinus disease. He considers that intranasal treatment and drainage are of use in the acute form only. When perforation from an infected sinus occurs into the orbit, it is usually through the lamina papyracea of the ethmoid and occasionally through the frontal floor. The pus burrows under the periosteum, causing exophthalmos. It is an advantage to remove part of the middle turbinal a few days before the external operation, although Killian claims that the virulence of the infection is thereby increased. Under ether a skin incision is made along the orbital margin parallel to and just below the line of the eyebrow, then down along the inner orbital wall and side of the nose to the orbital floor. No post-nasal plug is necessary. The periosteum is next incised at the orbital margin, above and in line with the skin incision, along the nose and raised with a sharp elevator. The orbital contents with the sac which must be carefully detached, are then retracted. The pulley of the superior oblique also requires care in detaching, as serious disturbance of the ocular muscle balance may result. A blunt periosteotome may be used from behind forward to dislodge that portion of the periosteum which supports the pulley. If, instead of the usual rough depression, the pulley is attached to a bony spine, the latter may be pried off with a flat chisel and will re-attach when the wound is closed. The next step is to remove the floor of the frontal sinus with chisels and hammer. Diseased tissue and septa are then removed with curettes. Next the nasal process of the superior maxillary, the lacrimal bone and os planum of the ethmoid are removed. Knapp here uses a curved, shovel-shaped retractor and a flat one shaped like a tongue depressor to retract the orbital contents from the field. Jansen's forceps, Hartmann's conchotome and curettes are employed to remove the cells of the ethmoid, keeping below the anterior ethmoidal foramen which marks the level of the cribriform plate of the ethmoid and remembering that the ethmoid becomes broader posteriorly. The rest of the middle turbinate may now be removed and the sphenoid reached if necessary. In case the frontal sinus is very extensive the upper lip of the original incision may be forcibly retracted upward and a portion of the anterior wall removed, leaving a bony bridge covered with periosteum as in the Killian operation. Knapp does not suture the external wound although it would seem of some advantage to at least suture the horizontal wound along the orbital margin, leaving a gauze wick in the lower wound. Gauze is also packed into the ethmoidal region to provide drainage toward the nose and to prevent hemorrhage. The drainage at the inner orbital angle is retained from 7 to 10 days and the nasal cavity is left undisturbed. There is usually diplopia for a few days but this entirely disappears even in the lower part of the field, as shown by colored glass and candle tests. Knapp describes his operation as a modification of those of Kuhnt and Jansen.

The first to suggest the osteoplastic resection of the anterior wall of the frontal sinus was Czerny (*Archiv. f. Klinische Chirurgie*, Bd. 50, Heft 3. 1895, S. 544). His procedure consisted in making a curved incision over the glabella with the convexity downward, outlining a flap with the base in the middle of the forehead. After extending the incision down to the bone the latter was cut through by means of chisels along the line of the incision and the whole lifted upward, exposing the frontal sinus.

Practically the same method was used by Volkovitch who presented a patient thus operated upon at the Sixth Congress of Russian Physicians held in Kyeff, April 25, 1896.



Golovine's Osteoplastic Frontal Sinus Operation. Heavy Black Lines show skin incisions. Dotted line shows bone flap.

Golovine (Lesions of the Frontal Sinus, Whitman's Translation *Archives of Ophthal.,* May 1898, p. 294) also in 1895, and independently of Czerny, devised an osteoplastic method of opening the frontal sinus. The skin incision is made along the upper border of the median half of the eyebrow and is about 4 cm. long. At the median end of the first incision a second incision is made obliquely to the first following the line of the corrugator muscle of the eyebrow. The two incisions, when completed, appear as the letter T lying on its side. the cross-arm of the T lying obliquely in the median line (see the figure). The soft tissues down to the periosteum are now retracted upward and a curved incision 2 cm. high is made through the periosteum, the base occupying the inner third of the supraorbital ridge. A groove is now made in the frontal bone along the line of the periosteal incision. Next, the bone flap is cut through along the groove with a thin, flat chisel, held obliquely, and is then raised and reflected downward permitting of a thorough curettement of the interior of the sinus. Drainage is left from the sinus into the nose and the flap replaced and sutured. Golovine also reports excellent results from the application of steam for thirty seconds at a sitting to destroy the lining membrane of the frontal sinus in chronic cases.

Maxillary sinus. The maxillary sinus or antrum of Highmore is the largest of the nasal accessory sinuses. It lies in the superior maxillary bone, its roof, in which we are especially interested, forming the floor of the orbit, its median wall facing the nose, its anterior wall forming the facial surface of the superior maxilla, and the posterior walls bounding the pterygoid fossa and at the inner upper angle bordering on the cranial cavity.

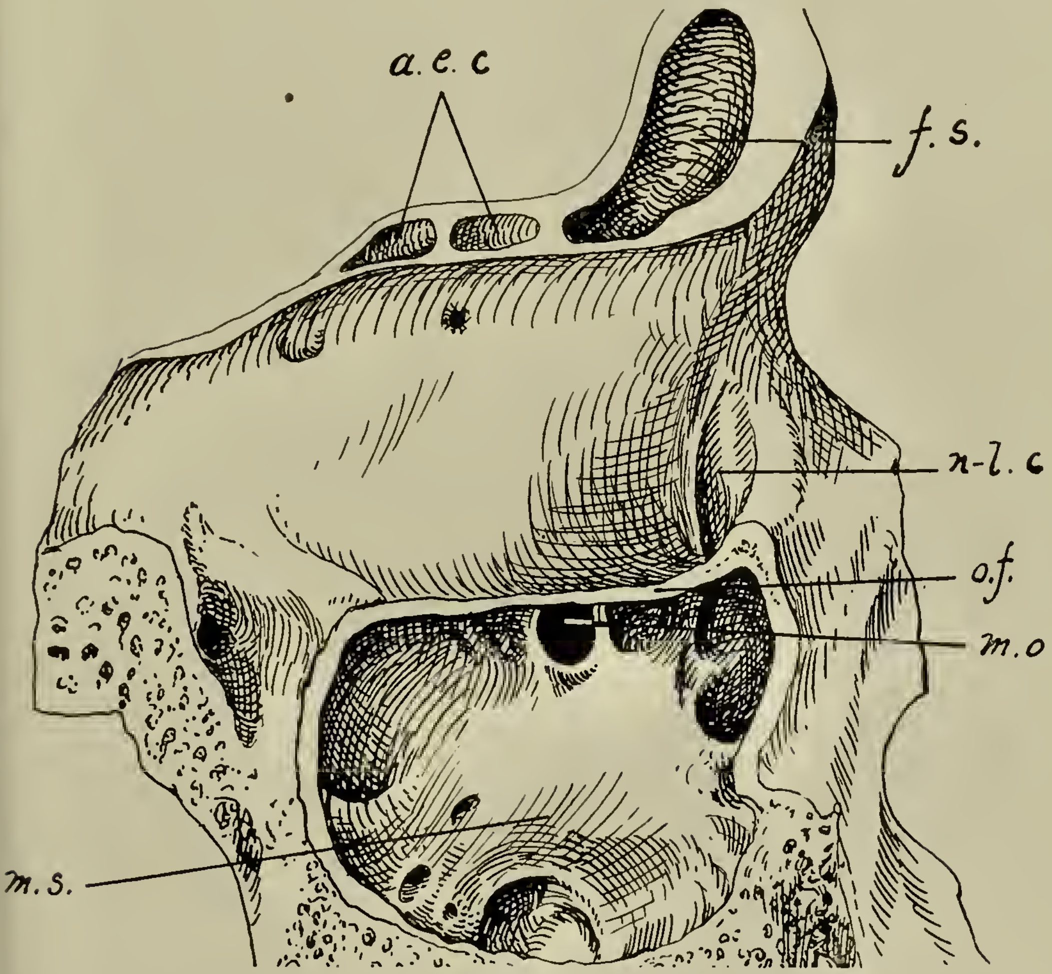
Loeb (*Annals of Otol., Rhin. and Laryn.,* June 1909) gives the maxillary sinus measurements as follows: antero-posterior diameter 17 to 42 mm., supero-inferior 17 to 42 mm., lateral 8 to 33 mm. The distance from the optic nerve varied from 7 to 25 mm.

The antrum is roughly pyramidal in shape, the base being formed by the nasal wall. This wall is the thinnest where it forms part of the middle meatus, being in this region partly membranous.

The accessory ostium of the antrum lies in this membranous region. The only practical importance of this area is found in its lack of resistance, should an artificial opening be necessary when the natural opening is inaccessible. However, the possibility of entering the orbit from this point is so great that this route to the antrum is seldom employed. The natural ostium of the maxillary sinus opens into the lower portion of the hiatus semilunaris in the middle meatus of the nose. As seen from the antrum it is small and round or oval in shape and lies in the upper part of the wall, its high position above the floor rendering drainage of the cell difficult. The size of the ostium varies. In one case where it was found to be 19 mm. long it occupied the entire hiatus. The remainder of the naso-antral wall is of bone, varying in thickness from 3 mm. or more at the base where it meets the floor of the nose to almost paper thinness in the upper part of the inferior meatus where the diagnostic puncture is best made.

The roof of the maxillary sinus is the thin orbital plate of the superior maxilla and contains the canal of the infraorbital vessels and the superior maxillary nerve. This canal often presents as a ridge on the antral roof and should be avoided in operations as it is very thin. The roof of the antrum has also been found to contain congenital dehiscences according to Zuckerkandl (quoted by Onodi.

Laryngoscope, Nov. 1909) giving direct communication between antrum and orbit. The antrum has been known in one instance to communicate with the posterior ethmoidal cells, and Onodi (*Laryngoscope,* Nov. 1909) describes such a relation existing between the anterior ethmoidal cells and the antrum. In this way an infection of the maxillary sinus may produce indirect orbital involvement.



Relation of the Maxillary Sinus to the Orbit.

o. f., Orbital floor; m. s., Maxillary sinus; m. o., Maxillary ostium; n. l. c., Naso lacrimal canal; f. s., Frontal sinus; a. e. c., Anterior ethmoidal cells.

The floor of the antrum is closely related to the alveolar process of the superior maxilla and is frequently encroached upon by the roots of the second bicuspid and first molar teeth. The alveoli of these teeth, in the event of their being diseased, offer a route for entering the antrum by means of a drill. The variation in thickness of the alveolar process and the fact that drainage occurs into the mouth, together with the probability of re-infection from the mouth, are the serious objections to this route.

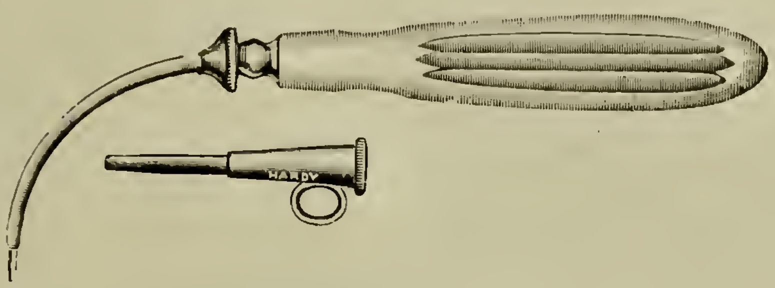
The maxillary antra are subject to as great variation in size, shape and relative position as the frontal sinuses previously described. Hajek (*Nebenhöhlen der Nase,* 1903) states that without doubt a thick alveolar process protects the antrum and a thin process predisposes it to extension of disease from the teeth. In addition to the so-called sinus alveolaris which is occasionally found as a small cell between the antrum floor and the alveolar process of the superior maxilla, the antrum may contain many recesses walled off by partial partitions. One of these, the infraorbital recess, is important from its position in the frontal process of the superior maxilla where the depression for the lacrimal sac shows as a bony prominence on its inner wall. These anatomical variations are important because of the possibility of error in entering the sinus. Should the facial wall be unusually flat or receding, entrance through the alveolar route would result in opening into the canine fossa. Or if the nasal wall were curved toward the antrum the nasal floor would be reached by the alveolar operation, etc.

The maxillary sinus is lined by a thin layer of muco-periosteum which is continuous with the lining membrane of the middle meatus of the nose. There are few mucous glands and the epithelium is of the ciliated type.

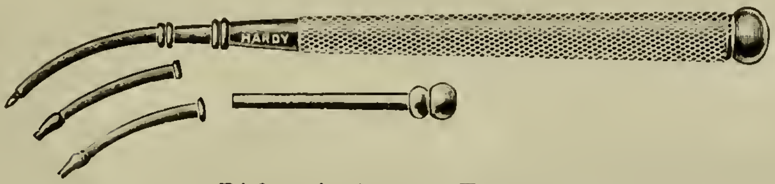
The subjective signs and symptoms of disease of the maxillary sinus are so variable as to be of little value. Pain and local tenderness are frequently absent in well-marked cases of antrum infection. The presence of secretion in the middle meatus anteriorly or even posteriorly in certain cases of unusually close application of the tip of the middle turbinal to the lateral nasal wall is significant of empyema of one or more of the cells emptying into the middle meatus, the frontal and maxillary sinuses and the anterior ethmoidal cells.

If, after wiping away the secretion, it at once reappears, especially if it is first seen high up near the anterior attachment of the middle turbinal, it is probable that the frontal sinus is the source. If it is slow in appearing, or appears only after holding the head forward with the affected side upward, the secretion probably comes from the antrum. By preparing the nose with cocain and suprarenalin 1 to 1000 applied to the middle turbinal and meatus secretion may be made to appear at the ostium of the infected sinus by means of the suction apparatus. This method is usually effective even in cases where the ostium maxillare is small or the secretion very thick.

The sinus may also be irrigated through the natural or an accessory ostium, or through an artificial opening made by a trocar in the antral wall of the inferior meatus. The ostium maxillare may frequently be found by means of a fine silver probe having 1 cm. of the tip bent at right angles to the main axis of the probe. The probe is passed into the nose with the bent end up and when opposite the hiatus semilunaris it is turned downward into the hiatus and moved up or down in an effort to locate the ostium. It may be necessary to vary the angle of the tip to the probe before the opening can be entered. An unusually narrow hiatus, due to close approximation of the bulla ethmoidalis to the uncinate process of the ethmoid and hypertrophy, or unusual position of the tip of the middle turbinal, may interfere with the passage of the probe. An accessory ostium is occasionally found under the middle third of the middle turbinal. When the correct angle has been found with the probe, a small silver cannula is bent to a corresponding angle and passed into the ostium in the same way or with the tip turned downward as the space permits. The cannula may now be connected with the author's irrigating apparatus and flushed with sterile physiological saline solution. The presence of secretion in the return flow from a nostril previously cleansed establishes the diagnosis of antral disease.



Myles Antrum Trocar and Author's Attachment for Irrigator.

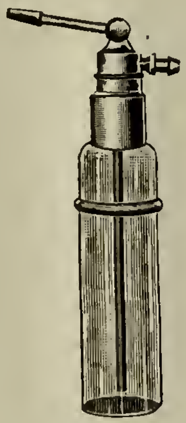


Dickson's Antrum Trocar.

When for any reason it is impossible to reach the natural opening, an artificial opening may be made, preferably with a curved trocar such as the Myles.

Dickson (*Laryngoscope,* May 1910) has devised an instrument which he calls the "In Situ Trocar." The handle is long and affords a firm grasp. The trocar portion is curved and several curved cannulæ, each having a rounded hump near the distal end to retain its position within the antrum, are furnished with the outfit. The discomfort of frequently inserting a sharp trocar is thus avoided by leaving the cannula in situ and merely connecting it with the irrigating apparatus at each treatment.

The antral wall of the inferior meatus is anesthetized by swabbing it with cotton-wound applicator dipped first into a 1 to 1000 suprarenalin solution and then into powdered cocain. The trocar is then introduced under the inferior turbinal at the juncture of the anterior and middle thirds, avoiding the lacrimo-nasal duct, and is passed through the thin bone of the antral wall in the upper part of the meatus. The obturator is then removed and the cannula left in position ready for connection with the irrigating apparatus. Hajek first forces compressed air through the antrum in order to avoid the possibility of washing infectious material with the irrigating fluid into the surrounding tissues, should the trocar accidentally puncture the orbit or the anterior sinus wall.



Author's Treatment Bottle.

Where the antral wall of the inferior meatus is too thick to admit of puncture and various points along the wall have been tried in vain, an opening may be made through the middle meatus. The safest point in this region is below and somewhat posterior to the uncinate process of the ethmoid. Here one usually finds the membranous area of the middle meatus which offers only slight resistance to the trocar. The possibility of penetrating the orbit is, however, much greater in this region as the outer wall of the middle meatus frequently curves toward or joins the orbital plate of the superior maxilla.

The presence of hypertrophies in the middle meatus is an indication of underlying sinus disease which demands closer investigation.

The Röntgen ray and the various transilluminating lamps have a place in the diagnosis of antral disease, but after all, the surest method is to puncture the cell wall at a favorable point and obtain direct evidence of the presence of secretion. The author observed an extreme case of acute maxillary sinus infection where irrigation failed because an intense edema of the lining membrane had obliterated the sinus cavity. It was necessary to resect a portion of the inferior turbinal and the antral wall of the inferior meatus and then to cut away sufficient edematous membrane to produce free bleeding and proper drainage.

Cysts of the antrum of Highmore offer little difficulty in the differential diagnosis from an empyema. The distinctive feature of cyst formation is the dilatation of the sinus in the direction of the facial wall or fistula in the fossa canina, complications which never occur in empyema.

The particular treatment of disease of the antrum of Highmore is conservative as by irrigation, or surgical where it becomes necessary to secure better and more permanent drainage.

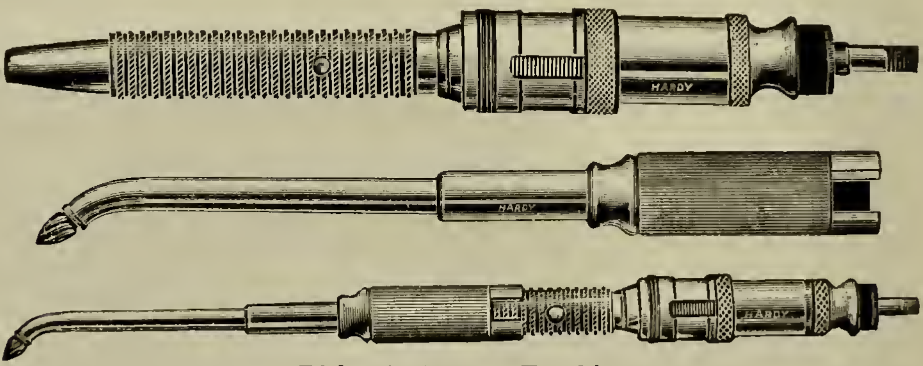
Irrigations may be effected by various means. One of the devices is connected with the cannula which has previously been passed into the antrum and one or more pints of a warm, sterile, physiological, saline solution forced through the cell. When the fluid returns from the cell entirely clear, the head is bent forward and, with the diseased side uppermost, compressed air is forced through the cannula to dry the interior of the sinus. Should it be necessary to use a medicament, argyrol 10 per cent., nargol 1 per cent., zinc chloride or silver nitrate 0.5 per cent., xeroform, iodoform or formidine powder may be introduced by attaching one of the treatment bottles, containing the particular solution or powder desired, to the cannula and applying compressed air from the usual cut-off.

Where it is found necessary to pass a trocar into the antrum the original point of entrance should be cocainized and the trocar re-introduced at each treatment. This maneuver is easily carried out with practice, taking care to observe the point at which the trocar crosses the inferior turbinal and the angle at which it enters the antrum, the head being held always in the primary position.

This form of treatment suffices for practically all recent cases. Chronic antrum discharge, however, is seldom controlled by this method as there is usually present disease of the lining membrane, periosteum or underlying bone which will yield only to the radical removal of the diseased tissue with perfect drainage and aëration of the cell.

The earliest conservative method of entering the antrum is that devised by Sir Astley Cooper, and is frequently called the alveolar route. The second bicuspid or first molar tooth, whose roots frequently extend to the antrum floor, is first removed and then an opening is drilled through the alveolar process into the antrum. It has the disadvantage that a tooth must be sacrificed and so is chiefly used where disease of the tooth possibly affecting the antrum is suspected. The opening is small and requires a prothesis to prevent its closing and the antrum is constantly exposed to re-infection from the mouth.

In cases where the naso-antral wall is very thick or the Cooper method would necessitate the removal of a sound tooth, an opening may be made in the canine fossa with chisel or trephine and maintained with a prothesis. Patients who cannot afford the time for treatments may easily be taught to irrigate the antrum through such an opening.



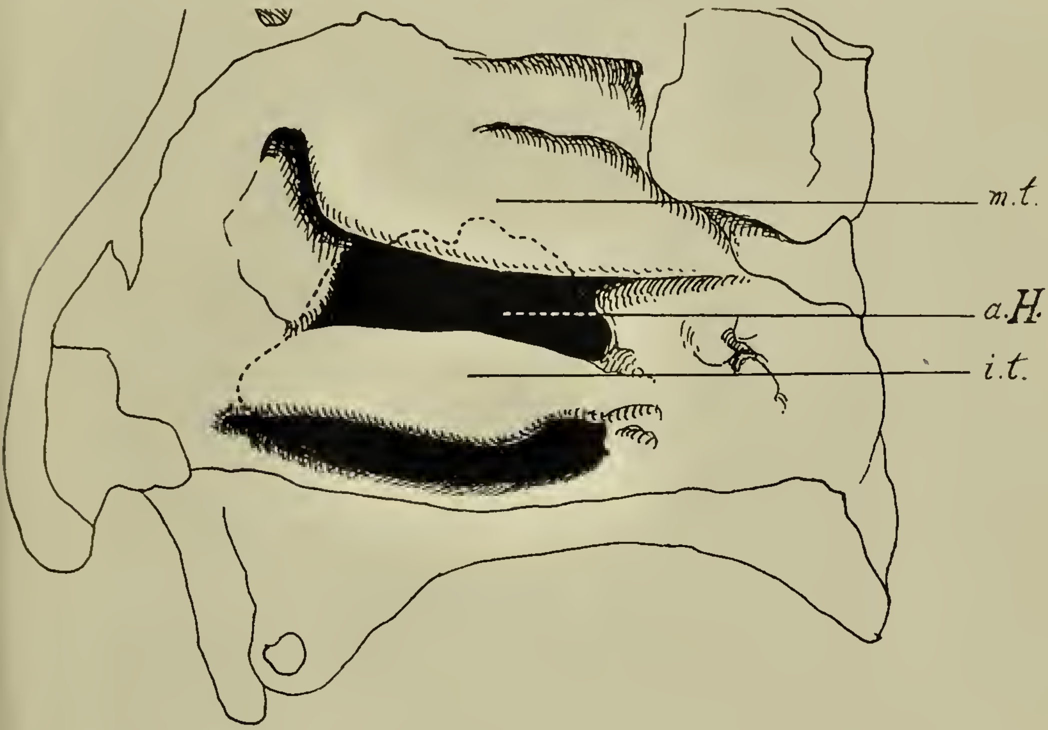
Bishop's Antrum Trephine.

Parker (*Jour. Minnesota State Med. Assn.*, Nov. 15, 1907) proposes to enter the antrum by removing the anterior two-thirds of the inferior turbinal and drilling an opening through the naso-antral wall which is then enlarged by Grünwald forceps and the Sonnenkalb antrum punch. He considers a large opening necessary.

Bishop (*Laryngoscope*, Nov. 1909) presents an instrument for drilling through the naso-antral wall, consisting of a sleeve bent at an angle of 50 degrees, a flexible shaft into which the burr is screwed and the whole fitting the handle of a Victor drill outfit. An opening of any size is easily cut through the naso-antral wall.

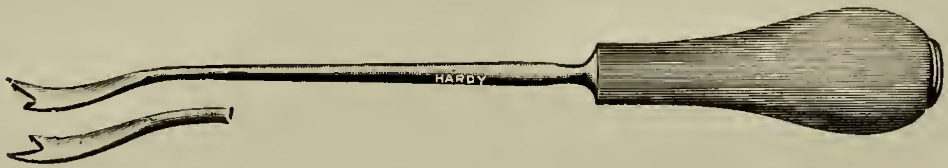
Rethi (*Wiener Med. Wochenschr.*, No. 1, 1909) believes in the efficacy of the intranasal removal of a large part of the naso-antral wall in chronic antrum disease. He removes fully two-thirds of the inferior turbinal and after entering the antrum with a chisel anteriorly, he uses bone forceps to remove the naso-antral wall as close to the floor of the nose as possible and also well up into the middle meatus. Small mirrors enable the operator to locate diseased areas within the cell which may easily be curetted through the large opening. He reports forty-nine cures in fifty-eight cases, the remaining nine being improved but not cured.

Myles (*Trans. Amer. Laryn. Assn.*, 1905) advocates a conservative operation on the maxillary sinuses which consists in removing as much as possible of the naso-antral wall in the inferior meatus by means of curved chisels which cut going in and coming out, rongeur forceps and the electric trephine. In some instances part of the inferior turbinal is removed, together with the naso-antral wall in the middle meatus. Malleable-handle curettes are used to remove diseased tissue and one-half inch iodoform gauze is used to pack the cavity. The after-treatment is by irrigation.



Modified Mikulicz Intranasal Operation upon the Antrum of Highmore. m. t., Middle turbinal; a. h., Antrum of Highmore; i. t., Inferior turbinal reattached. (After Sluder.)

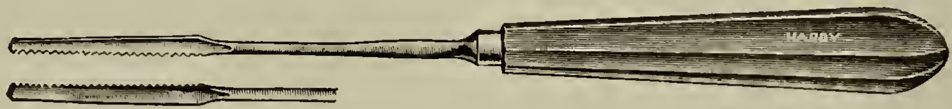
Leland (*Trans. Amer. Laryn. Assn.*, 1905) makes a plea for a thorough trial of conservative methods in dealing with maxillary sinus disease. After correction of septal deviations, removal of an enlarged ethmoid bulla or uncinate process and of hypertrophies in the middle meatus, he makes a large opening into the antrum through the middle meatus with a hook similar to Hajek's but stronger, and with a broader blade. This opening may be enlarged with cutting forceps. The inferior turbinal, the most important for nasal respiration, is thus left intact. The opening is kept free from granulations by forceps and caustics, and the antrum irrigated. The patient is instructed to cleanse the sinus frequently by turning the head to one side to bring the opening to the lowest point and forcibly blowing the nose.



Antro-Nasal Chisel. Right and Left. (Stein.)

Curtis (*Laryngoscope,* July 1906, p. 542) believes from his experience that four-fifths of all cases of empyema of the maxillary sinuses may be treated successfully by removal intranasally of a large portion of the naso-antral wall.

Sludei (A Modified Mikulicz Operation, *Laryngoscope,* Dec. 1909, p. 906) has modified the Mikuliez operation for removing the wall of the inferior meatus intranasally. The inferior turbinal is detached with scissors as far back as its posterior fourth or fifth and pushed upward out of the operative field. The lateral wall of the inferior meatus is next removed and the detached inferior turbinal pushed downward to the nasal floor to make room for the removal of a portion of the antral wall of the middle meatus. After removing as much as desired of the naso-antral wall, the detached turbinal is replaced and re-attachment takes place to the nasal process of the superior maxilla. The turbinal is retained in position by means of cotton or gauze tampons or by sutures. Sluder has operated upon fifty-three cases and has never seen the bone fail to unite and has never observed any degeneration or hypertrophy of the inferior turbinal following the operation. The advantages, from a physiological standpoint, of leaving the inferior turbinal, are obvious, especially



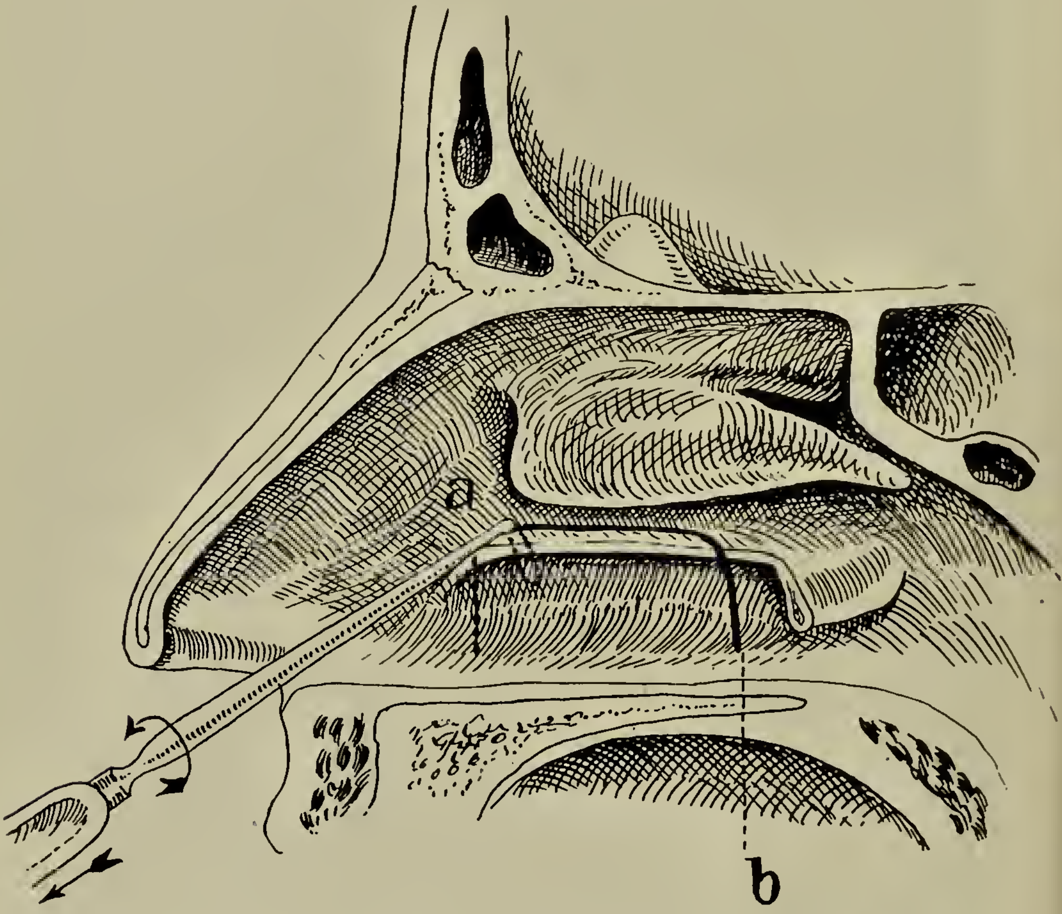
Antrum Saws. Right and Left. (Vail.)

where it has been necessary to sacrifice the greater portion of the middle turbinal.

Stein (*Laryngoscope,* Feb. 1910) suggests the removal of the naso-antral wall by means of an instrument shaped like a narrow spoon with the tip of the bowl cut off and notched in a V. One point of the V-shaped end is forced through the naso-antral wall at a point just within the pyriform process with the concavity of the instrument directed toward the nasal floor. By depressing the handle the instrument cuts through the thin wall of the middle meatus and by raising the handle it can be made to cut downward through the inferior turbinal at any desired point. The instrument is now removed and re-entered at the original point but with the concavity upward and is made to cut through the antral wall as close to the floor as the bone thickness permits. No account seems to be taken of the nasal portion of the lacrimal duct. However, a second method similar in detail to the first, but confined to that portion of the wall in the inferior meatus, is also suggested and this, of course, would successfully avoid the lacrimal duct.

Vail (*Trans. Amer. Academy Oph. and Oto-Laryng.,* 1907) presents an operation for the removal of the nasal wall of the maxillary antrum intranasally. The antrum wall is punctured at the middle of the inferior turbinal with a strong, two-edged bistoury and the blade forced backward and forward to enlarge the opening. A blunt saw curved on the flat and 4 mm. in diameter is then introduced with the teeth forward and aided by the shallow curve is made to cut out a round button including the middle 1/3 of the inferior turbinal and the naso-antral wall. Any loose mucous membrane is trimmed away with scissors and the wound packed. Vail suggests that in case polypi are found in the antrum and a complete curettement is necessary, the canine fossa may be opened under local infiltration anesthesia and the entire cavity exposed, a sort of reversed Caldwell-Luc operation. A grooved saw was first invented by Pynchon for the removal of low spurs, a fact, however, unknown to Vail at the time he devised his saws. An important point in this operation is the preservation of the important anterior end of the inferior turbinal which regulates the blood supply of the turbinal erectile tissue, according to the humidity, temperature and barometric pressure of the air inhaled.

Choronshitzky (*Archiv. f. Laryn. and Rhin.,* Bd. 22, Heft. 3, pp. 498-507) states that the object of operating upon the antrum is to insure thorough cleansing, removal of all diseased tissue and a permanent opening. He obtains local anesthesia by infiltration of ½ per cent. cocain with adrenalin. The first molar tooth is extracted and one of the buccal canals enlarged with a drill into the antrum. The inner or lingual canal is enlarged and prolonged in the same way through the nasal floor under the inferior turbinal. These openings are enlarged alternately with drills of increasing size until a Y-shaped opening results. The intervening bridge is then cut away with a narrow conchotome or bone forceps. The cutting is done under the direction of the eye and the antral wall is removed up to the attachment of the inferior turbinal and as far forward and backward as possible. The sinus is now dried with gauze strips and diseased, hypertrophied, fungoid tissue is removed. Choronshitzky has not seen polypi in fifteen cases operated by this method. The sinus is packed with iodoform gauze from both nose and alveolar opening. The gauze tampon is continued, and as needed points of excessive granulation are curetted. The tampon is stopped when secretion has

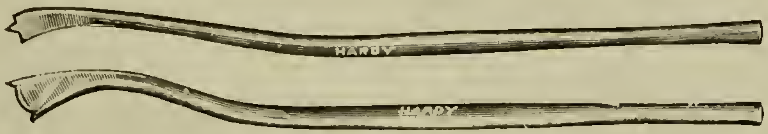


Method of Intranasal Removal of the Naso-Antral Wall.

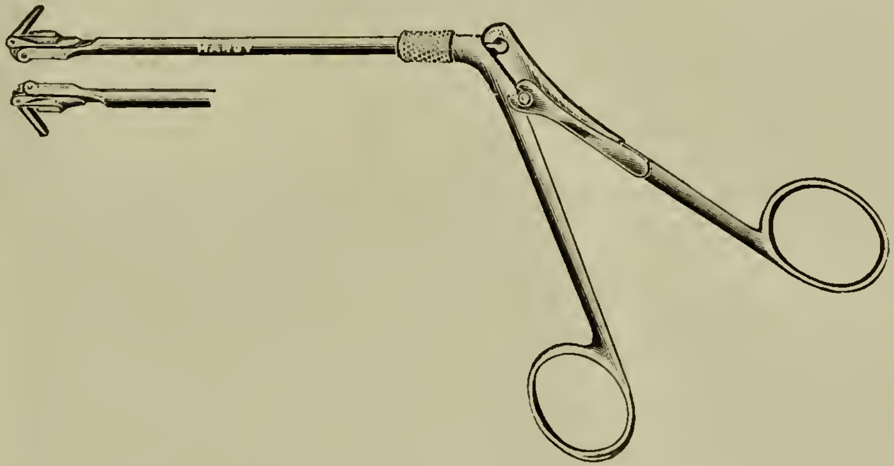
b, Point where knife is introduced; a, Point where knife is turned to cut downward along dotted line. (After Ballenger.)

practically stopped. The alveolar wound is allowed to close gradually and the antrum treated through the nose.

Ballenger (*Diseases of Nose, Throat and Ear,* 1909, p. 221), under local anesthesia removes the anterior half of the inferior turbinal with his right-angle knife. The knife enters the turbinal at the middle point and cuts through it to its attachment to the nasal wall, and is then drawn forward following the line of attachment, removing the anterior half. The knife is next made to cut through the naso-antral wall at the posterior limit of the antrum and an upward incision made as high as desired. The knife is then pulled forward, making an incision parallel to the nasal floor and then avoiding the lacrimo-nasal duct a downward incision is made. The reverse knife is now entered at the posterior incision from which it is made to cut forward as close to the floor of the nose as the thickness of the antral wall will permit. The thickest portion of the wall at the nasal floor may be removed with bone forceps. Iodoform gauze is used to loosely pack the cavity for 24 or 48 hours and later exuberant granulations are controlled with caustics.



Antrum Chisels. (Corwin.)



Reversible Antrum Punch. (Ostrum.)

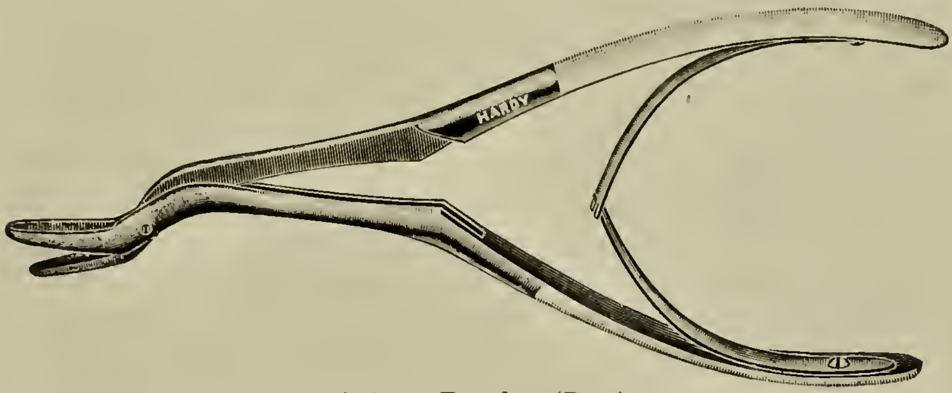
Corwin has designed a pair of curved chisels to remove a similar section of the naso-antral wall.

Ostrum uses his forward cutting forceps to remove the wall, especially the anterior portion which is the most difficult to reach.

The supraturbinal maxillary sinus operation. This method of opening the maxillary sinus was first reported by Wagner (Langenbeck's *Archiv.* Bd. 11, 1869), who used the little finger to break down the membranous antral wall. Since Wagner's time many authors have described similar operations, using various instruments. Onodi (Die Eröffnung der Kieferhöhle in Mittleren Nasengange. *Archiv. f. Laryngolgie,* Bd. 14, S. 154, 1903) has devised a dilation trocar to cut through the fontanelle and follow this with a sharp curette or punch-forceps to cut away the torn down membrane. Kubo (Ueber die supraturbinale Eröffnung bei Sinusitis maxillaris chronica. *Archiv. f. Laryngologie,* Bd. 26, S. 351, 1912) has chosen this point of attack because of the ease with which the membranous wall may be removed and because it is the natural site for an opening, containing as it does the natural ostia of the sinus. The operation is simple and leaves a large opening, making it possible for the patient to irrigate his own antrum. The danger points are the orbital wall and the lacrimal duct. After the application of 20 per cent. cocain and adrenalin to the region of the middle meatus, middle and inferior turbinals and septum, Kubo injects 0.5 to 1.0 c. c. of 0.5 per cent. cocain, containing 2 drops of adrenalin to each c.c., into the region of the agger nasi. The membrane is cut through with a special cutting forceps, a combination of the Hartmann conchotome and the Killian double curette. The sinus is entered at a point between the processus uncinatus and the accessory ostium. The opening is then enlarged forward by means of a curette and backward by the Hartmann conchotome. The after-treatment consists in cleansing the wound with hydrogen peroxide and daily irrigation of the sinus through the new opening. The operation is not suggested as a cure-all and naturally a certain percentage of these cases will later require the radical operation.

Roe (Methods of Opening the Maxillary Antrum, with Presentation of a New Instrument. *Annals Otol., Rhin. and Laryn.,* June 1909, p. 415) has devised a strong punch-forceps for the intranasal removal of the naso-antral wall. There are two forms, one with the male blade entering the antrum for cases where the antrum floor is above the nasal, and the other with the female blade entering the antrum to be used when the antrum floor is below the level of the floor of the nose.

Roe usually finds it necessary to remove the lower anterior portion of the inferior turbinal to reach the antral wall. His next step is to incise the mucoperiosteum along a line just below the attachment of the inferior turbinal and throughout the extent of the antrum with a small angle knife. By noting the conformation of the upper jaw and if necessary using the X-ray, the position of the antrum, especially its forward projection, may be outlined. The mucoperiosteal incision is turned downward at the anterior limit of the antrum and a similar downward incision made at the posterior limit, the downward incisions being carried to the nasal floor. The flap thus outlined is elevated and turned toward the nasal septum. The antrum is then opened anteriorly and near its floor, preferably with a Myles' curved antrum gauge. The opening is made large enough to admit the blade of the punch-forceps, and this instrument then cuts away the entire antral wall below the inferior turbinal attachment. The wall should be carefully removed and smoothed off level with the nasal and antral floors. Then, after removing any polypi or secretion which may be present, the flap is placed in position, covering the stump of the removed naso-antral wall, and the antrum packed with iodoform gauze. Roe finds that the radical removal of the lining membrane of the sinus is seldom necessary, as the increased drainage and aëration usually results in a return to normal of the greater part of the diseased membrane.



Antrum Punch. (Roe.)

Canfield's operation. (The Submucous Resection of the Lateral Nasal Wall, etc. *Jour. A. M. A.*, pp. 1136, 1908.) Canfield has devised a method of opening the antrum at its anterior, inferior angle. The area about anterior to the attachment of the inferior turbinal is cocainized and injections of 1 per cent. cocain made toward the fossa canina and then toward the inferior turbinate. A vertical incision extending to the bone is then made, beginning at the attachment of the inferior turbinal and reaching to the nasal floor. The mucoperiosteum is now elevated and the bony wall about the crista pyriformis is exposed. The antrum is now opened with a chisel or trephine and inspected, using a head mirror or electric headlight for illumination. All pathologic tissue is removed with curettes and the sinus packed with a strip of xeroform or iodoform gauze. The chief advantage of this method lies in the opportunity afforded for direct inspection and in conservation of the inferior turbinal.

Radical operation. The radical operation for disease of the maxillary sinus was first performed by Lamorier in 1766 (quoted by Hajek, *Nebenhöhlen der Nase,* 1903, S. 115). It was later revived by Desault and modified by Küster (*Deutsche Med. Wochenschrift,* 1889, S. 233). Küster considers that the only serious objection to opening the facial wall of the maxillary sinus is the exposure to food and infectious material from the mouth. He avoids this by making a flap of mucoperiosteum from the first bicuspid to the first molar tooth and reflects the flap upward. He then removes sufficient of the facial wall of the antrum to admit the little finger which is used to palpate the interior of the cell to locate diseased tissue, carious roots of teeth, etc. After the necessary curettement the sinus is irrigated and loosely packed with iodoform gauze. The packing is removed in a few days and a gauze drain substituted. The flap closes the opening rapidly, only the use of the gauze drain preventing complete closure.

Hajek (*Nebenhöhlen der Nase,* 1903) describes a modified Küster operation. The patient is placed in a half-reclining position with the side to be operated uppermost. The upper lip is retracted and an incision made along the labio-gingival fold, through mucosa and periosteum, and the wound edges retracted. The bony wall is next removed with the electric trephine or with chisels. Usually there is very little bleeding, which may be arrested by compression or by crushing the small vessels with artery forceps. After sufficient bone has been removed to expose the interior of the cell, it is irrigated with 1 to 5,000 bichloride of mercury solution. The lining membrane may now be examined and diseased areas removed, the bone wound being enlarged with bone forceps as required. The cell is now packed with iodoform or xeroform gauze, the ends of which are allowed to project through the wound.

The gauze is carefully removed in four or five days and renewed as the drainage demands for about two weeks, until the margins heal by granulation. A hollow prothesis is now inserted to maintain the opening and ventilate the sinus. The after-treatment is carried out by means of large specula similar to ear specula, but having a diameter of 6 mm. to 1 cm. Granulations, hypertrophies, etc., may be removed through the speculum by means of curettes; small punch-forceps or snare under illumination from a head mirror or electric headlight. A headlight such as the Klaar (see the figure) is also very useful during the operation.

Hajek seldom finds necrotic bone in the antrum, although Grünwald claims to have found necrosis frequently. Where the lining membrane is thickened and edematous with unhealthy granulations, a large opening with practically complete removal of the diseased membrane is necessary. Jansen follows this method and forms a flap from the mucoperiosteum of the facial wall or uses skin-grafts, to cover the denuded bone. Such extensive pathological changes are, fortunately, seldom encountered, so that the Jansen method is seldom necessary.

Klaar Electric Headlight.

Boeninghaus (*Archiv. f. Laryng.*, Bd. VI, 1897), after removing the entire lining membrane, goes a step farther and cuts away the naso-antral wall. The lower half of the wall is removed with chisels without injuring the nasal mucous membrane. The inferior turbinal is next dissected out and the thin upper portion of the naso-antral wall removed with a curette, leaving only a curtain of nasal mucosa between the nose and the antrum. This is cut through above, anteriorly and posteriorly, and used to line as much as possible of the denuded antrum walls. The mucoperiosteum of the facial wall is used similarly and both flaps are retained in position by gauze tampons. The tampons are removed in from four to five days, the subsequent treatment consisting of caustics such as chromic or trichloracetic acid applied where needed to control excessive granulations.

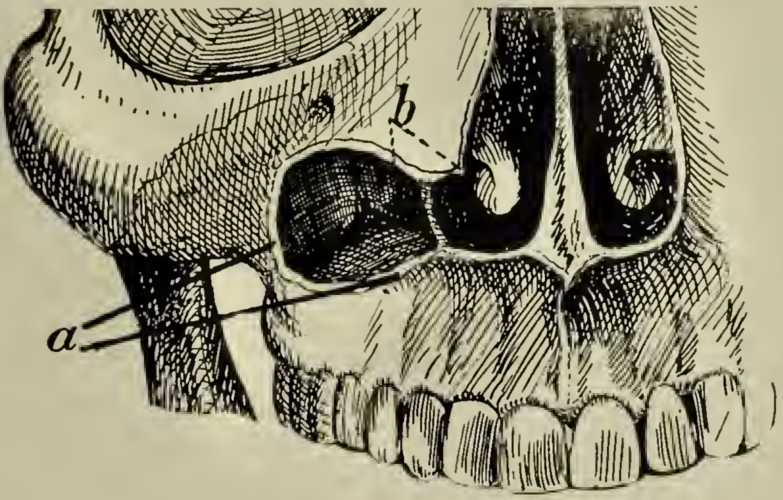
Claus (*Archiv. f. Laryngol.*, 1904, Bd. XVI, S. 102) in operating for chronic maxillary sinusitis removes the anterior sinus wall completely with chisels and Hajek's bone forceps, which have the advantage of throwing the bone fragments outward. All diseased tissue is systematically removed from the interior of the cell and gauze tampons, usually saturated with protargol, are continued until the sinus is obliterated.

Hajek (*Nebenhöhlen der Nase,* 1903, S. 121) describes the radical antrum operation of Caldwell-Luc. General anesthesia is necessary. The incision follows the line of attachment of the mucous membrane of the lip to the facial wall and extends from the canine to the second molar tooth. The mucoperiosteum is detached upward and held out of the field with retractors. The facial wall of the antrum is next chiseled away practically in its entirety and the antrum swabbed dry and inspected by artificial light. All diseased areas are removed with curettes and cutting forceps. The best drainage is obtained by removing the nasal wall as low down as possible. The bony wall of the inferior meatus is removed carefully with a flat chisel, leaving the nasal mucous membrane intact. The wall is removed over an area at least 3 cm. long and upward to the attachment of the inferior turbinal. A probe passed into the inferior meatus at its root from the nasal side is now used to press the membranous inferior meatal wall into the antrum, where it is cut through longitudinally the length of the bone wound. The flap is now incised at either end and used to cover the antrum floor. If the inferior turbinal be hypertrophied, it may be necessary to remove a portion of it to give better access to the interior of the antrum. This may be done from the antrum by cutting horizontally through the thin bone just above the inferior turbinal attachment and with the inferior turbinal held with strong forceps, a section may be removed by cutting through the turbinal anteriorly and then posteriorly to the forceps. The sinus is now packed loosely with moist iodoform gauze and the end of the packing left in the nasal opening. The mucoperiosteum of the cheek is now sutured into position. The gauze is left in situ 10 days or two weeks if conditions are favorable and no severe pain or high temperature results. Powdered iodoform may, after the removal of the gauze, be blown into the antrum through the nasal opening a few times. Hajek believes that irrigation is to be avoided as it increases secretion and produces irritation of the fresh granulations. It often requires six months to one year for complete cicatrization to take place, but if the after treatment is not too vigorous this process goes on without annoyance to the patient.

The Denker operation. This is the most radical method yet devised for operating on the maxillary sinus. It is indicated in those obstinate, chronic cases where the more conservative measures have failed.

The greatest advantage is the exposure of the anterior angle of the sinus next the nose, which is usually the seat of pathologic lesions and which other methods of operating fail to reach.

Under general anesthesia the patient is placed on his back with the head hanging over the end of the table—the Rose position. The throat is protected by post-nasal tampons. An incision is made along the labio-gingival juncture from the second molar to the median line and the periosteum with the overlying soft tissues elevated over the canine fossa. The anterior wall of the antrum is removed with chisel and bone forceps as in the previously described methods. Next, the thick bridge of bone between the usual canine fossa opening and the apertura pyriformis of the nose is removed, exposing the anterior inner angle of the antrum. The interior of the cell is now inspected and pathological tissue removed with the curette. A flap is now made by elevating the mucoperiosteum of the inferior meatus and of the inferior turbinal. The nasal wall of the antrum, together with the anterior third of the inferior turbinal, is removed with bone forceps. A large opening is made to insure perfect ventilation and drainage and the previously described flap is turned down upon the antral floor and retained in position with a loose gauze packing for about two days. After-treatment consists in cleansing the cell with physiological saline irrigations, drying it with compressed air and cauterizing exuberant granulations.



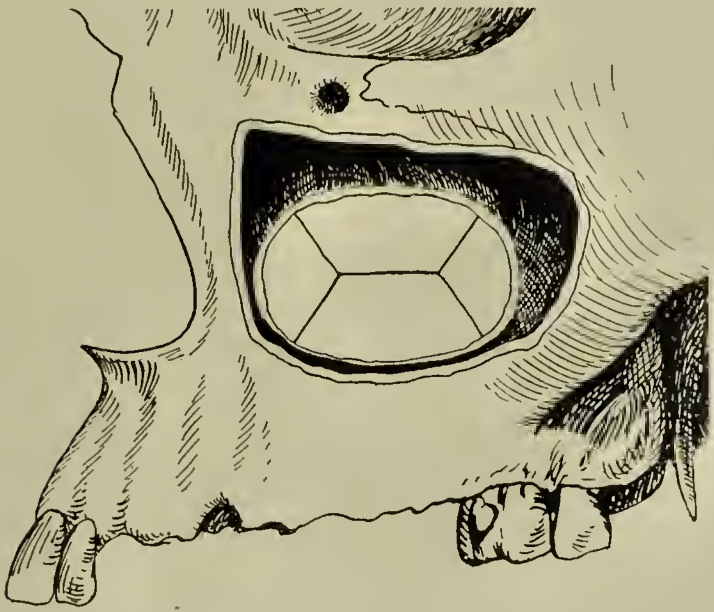
The Denker Radical Operation upon the Maxillary Sinus.

a, Portion of facial wall of the antrum which is removed in the Küster and Caldwell-Luc operations; b, Additional portion removed by the Denker operation.

The Sturmann operation. Sturmann (*Archiv. f. Laryn.,* Bd. 23, Heft 1, S. 143) reports on his method of intranasal removal of the naso-antral wall. The success of Denker's radical operation, which combined the good points of all previous operations, led to his effort to perfect a less radical procedure which would give equally good results. The important point is the removal of the nasal wall well forward, uncovering the most anterior portion of the antrum and thus obtaining space for perfect ventilation and inspection of the entire cavity. The trephine and drill are used instead of the chisel. The facial and nasal walls are cocainized and then injections are made under the mucoperiosteum in each area, using 2 c. c. of a solution containing cocain 0.0075 gm. and adrenalin 0.00005 gm. per c. c. of physiological saline solution. Two per cent. cocain may also be injected within the antrum. The injections are made in the same manner even if general anesthesia is to be used, as the bleeding, which at times is very great, is thus controlled. General anesthesia is given by means of the Kuhn method, a tube being introduced directly into the larynx. By an incision in the nasal aperture the facial and nasal walls of the antrum are uncovered and with an elongated Fränkel speculum retracting the membrane of the nasal wall and the soft tissues of the cheek, a large trephine is made to cut into the antrum horizontally through the anterior angle. Enough bone is removed along each wall to completely inspect the antrum. The nasal wall is removed level with the nasal and antral floors. The cell is cleansed and polypi removed, leaving all healthy or merely edematous membrane. By incising the mucous membrane wall left between the nose and antrum, along the upper wall of the cell and down anteriorly, a flap is made to cover the antral floor. This is held in position with gauze and the after-treatment is similar to that of the other radical procedures.

The Robertson operation. To avoid the loss of turbinal tissue and maintain a large communication between the antrum and the nose, Robertson (New Flap in the Radical Operation on the Accessory Sinuses. *Chicago Medical Recorder,* Feb. 1909) has devised a flap operation. An incision is made as usual from the second incisor along the labio-gingival juncture as far backward as necessary. The soft tissues of the facial wall are elevated as high as the infraorbital foramen and well over toward the nose. A large opening is made in the anterior antral wall and pathological tissue and bony septa removed. Next, the ethmoidal cells are curetted with a narrow, sharp, steel curette, avoiding the spheno-maxillary fossa immediately posterior to the antrum, the cranial cavity above, the orbit externally and the nasal cavity internally. When the ethmoidal cells have been removed for a distance of five and one-half to six cm. the sphenoidal sinus is reached and may be opened and, when necessary, curetted. Robertson lays special stress on smoothing off the ridges along the floor of the ethmoid labyrinth to facilitate drainage into the antrum. The details of forming the flap are given in the author's own words to insure accuracy:

"We next determine the line of attachment of the inferior turbinate bone on the inner wall of the antrum. This is easily seen by a slight ridge which usually presents into the cavity of the antrum. We now remove the bone between the inferior turbinate bone and the floor of the cavity, taking care to leave the nasal mucous membrane intact. The bone should be removed as far forward as possible to take in the anterior angle of the cavity, as this is a favorite spot for granulations, and on a flush with the floor of the antrum, so pus will have no place to lodge before it enters the inferior meatus. This is at times difficult either from the limited space the operator has to work in (where the antrum is small), or where the antrum floor lies lower than the nasal floor. It is also difficult to get the edges of the opening smooth on account of the splintering and breaking of the bony wall. If necessary the mucous membrane of the inferior meatus can be displaced inward, which gives the operator more room, and the opening can then be smoothed by means of an electric burr. After we have finished the bony opening the mucous membrane of the nose



Illustrating Robertson's Method of Cutting the Flap of Nasal Mucous Membrane in the radical operation upon the antrum of Highmore.

is seen to move in and out with the respiratory movement, and owing to the fact that we have not as yet entered the nostril, the hemorrhage into the nose has been little or none. After cleansing the newly made cavity, consisting of what was the antrum, ethmoidal cells and the sphenoid sinus, we are ready to open into the nostril. This is done by cutting a flap (as is shown in figure). The object in cutting the flap in this manner is so the opening into the antrum may be all covered by mucous membrane and thus avoid the filling up of the wound by granulation tissue. The illustration shows a cross section, with the mucous membrane flaps in position. Gauze strips which have been saturated with 1 per cent. yellow oxide ointment or iodoform are used, as the case may indicate. The first end of the gauze is passed into the sphenoid cell and then packed gently into the ethmoidal cells. As these cells are filled up the rest of the gauze is packed into the maxillary sinus with the last end passed through the opening into the inferior meatus. It requires care to hold the mucous membrane flaps in place during the last part of the packing, but this is essential to the operation and should receive the strictest attention. After the dressings are placed the wound in the mouth is closed with three or four silkworm sutures and a gauze pad saturated with boric solution kept under the lip for several days. If no reason necessitates, the gauze packing is not disturbed for four or five days and when removed is drawn from the nose with care as not to tear loose the mucous flaps from their new position.

"The advantages of this operation over the old form are:

"1. The cavity is rendered inoffensive on account of all the cells being destroyed.

"2. The turbinals are not cut or injured, allowing the patient all the physiological function of these tissues.

"3. The opening is permanent after three or more years, as has been demonstrated by the author.

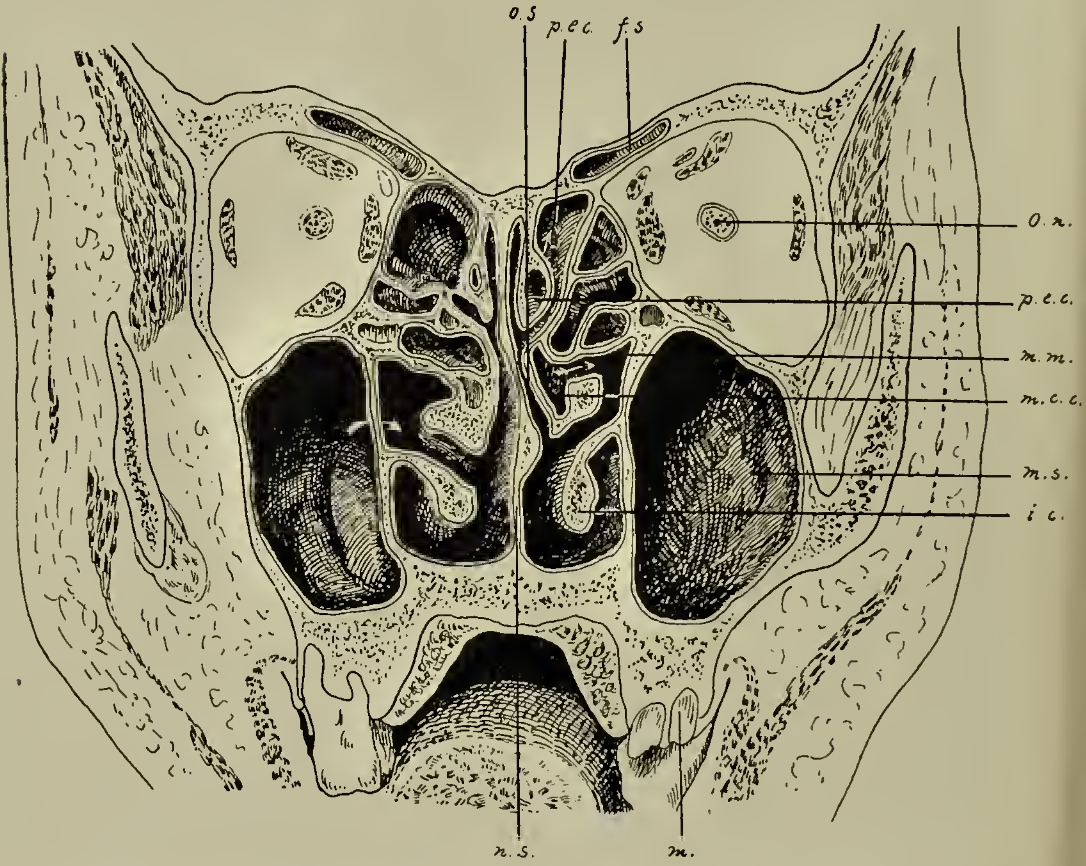
"4. The recurrence of empyema is rendered nil, because the cavity has ample and permanent drainage.

"5. The absence of prolonged after-treatment."

The after-treatment of antrum operations is so important as to permit of some repetition here. Irrigation of the antrum through artificial nasal opening, or through the Hajek prothesis, with warm physiological saline solution produces no irritation and is the best solvent for the secretions. For home treatment the simple rubber bulb syringe with two valves is probably the most efficient. The nasal opening is so large that the patient easily learns to pass a curved cannula into the antrum and do his own cleansing. Where the secretion is excessive one or two quarts of the solution may be used in a fountain syringe as frequently as needed to prevent accumulation of pus. The frequency of the irrigation depends upon the amount and character of the secretion. As the secretion lessens or assumes a more mucoid appearance and consistency with fewer pus cells, the treatment may be gradually lessened in frequency, but should not be at once discontinued upon the cessation of discharge, irrigations being continued two or three times weekly for several weeks longer. Great care should be observed in rendering the patient resistant to reinfection from ''colds'' by attention to diet, exercise, fresh air and adequate elimination. Regular inspection of these cases before and after office irrigations will often enable one to detect secretion in locations characteristic of infection of other sinuses, particularly the ethmoid. All hypertrophies, granulations, etc., should be cut away and the actual cautery or a chemical cautery, such as trichloracetic acid, applied to their bases. Most of the acute antrum empyemas heal spontaneously, but where the secretion continues for several weeks, or when there is pain and tenderness over the antrum and the second bicuspid and first molar teeth, or reflex pain along the branches of the fifth nerve with pressure sensations on stooping, the cell should be emptied by suction apparatus, irrigation through the natural opening or by puncture with a trocar and irrigation with physiological saline solution and 10 per cent. argyrol or similar non-irritating antiseptic injected. The bacterial findings are often an indication for more radical measures or more frequent, persistent treatment as in cases where pneumococci, streptococci or influenza bacilli are found. In general when the suppuration continues for three or four weeks, with no change in the character of the secretion toward a mucoid consistency, better drainage is indicated. The operation chosen should be one which may be performed under local anesthesia, such as the resection of a portion of the inferior turbinal and the antral wall of the inferior meatus intranasally. A small trephine opening in the fossa canina in cases where the patient for any reason cannot afford the time for treatment, allows of his carrying out the irrigation at home more easily perhaps than with an intranasal opening, although from its position does not give the constant drainage which occurs with an opening near the nasal floor in the inferior meatus. The process may be termed chronic when it continues for a period of two or three months. These cases, even where the process has continued for several years, may be cured by the irrigation treatment, which should always be tried, especially in nervous patients who will do anything to avoid operative measures. The more radical methods, such as the

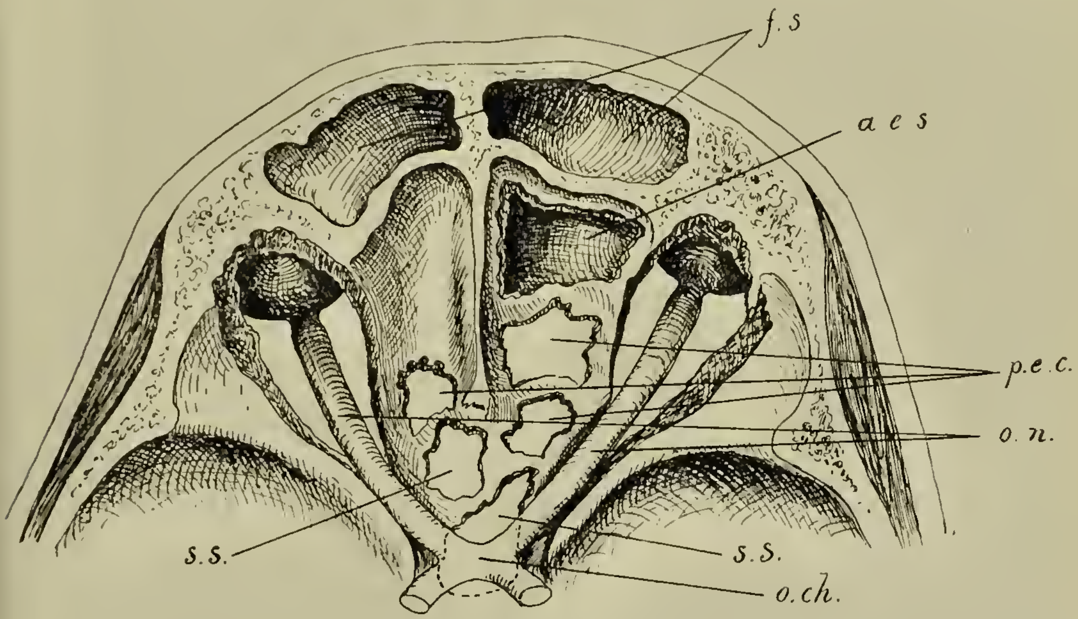
Caldwell-Luc, are indicated only in cases of long duration, or where the conservative measures have failed.

Ethmoid labyrinth. The ethmoid bone is made up of a vertical plate, which forms the upper part of the bony nasal septum, the horizontal cribriform plate and the two lateral masses of cells. These masses are made up of irregularly shaped air cells lying between the nose and the orbit, the external lateral surface, the lamina papyracea forming part of the inner orbital wall.



Relation of the Ethmoidal Cells and Nasal Accessory Sinuses to the Orbit. o, s, Olfactory sulcus; p, e, c, Posterior ethmoidal cells; f, s, Frontal sinus; o, n, Optic nerve; m, m, Middle meatus; m, c, c, Cell in middle turbinal; m, s, Maxillary sinus; i, c, Inferior turbinal; m, Molar tooth; n, s, Nasal septum.

The cell mass is roughly partitioned by the so-called basal lamellæ of Seydel (Über Nasenhöhle Säugetiere u. Menchen. *Morphol., Jahrb.* Leipzig, 1891), who described five. The first forms the uncinate process, the second the bulla of the ethmoid, the third and fourth the middle and superior turbinate bodies and occasionally a fifth is found bearing a still higher turbinate body. These lamellæ extend through the mass of cells to the os planum and up to the cribriform plate and are roughly divided by the middle turbinal and its lamella into an anterior and a posterior group. This division is also a clinical one as secretion from the anterior group drains into the middle meatus, the space underneath the middle turbinal, and secretion from the posterior group drains downward and backward over the middle turbinal. According to Logan Turner (*The Accessory Sinuses of the Nose,* 1902.) the superior boundary of the ethmoid labyrinth is the ethmoid edge of the orbital plate of the frontal bone with its depressions or foveæ. Inferiorly the ethmoidal margin of the orbital plate of the superior maxilla is the boundary line. Anteriorly the boundary is the lachrymal bone and the nasal process of the superior maxilla. Thus it is apparent that the ethmoidal labyrinth is in the closest relationship to the entire inner orbital wall, while posteriorly the ethmoid articulates with the sphenoid and in this region maintains a fairly constant relation to the optic nerve. The anterior group, except in extremely rare instances, has no relation to the optic nerve. On the contrary, the posterior ethmoidal cells, especially at the postero-external angle, are almost always found to border on the optic canal. The relation of the last cell of the posterior ethmoid group to the optic nerve was first demonstrated by Onodi (The Oculo-Orbital, Intracranial and Cerebral Complications of Diseases of the Nasal Accessory Sinuses. *Laryngoscope,* November 1909; and The Optic



Relation of Optic Chiasm, Optic Nerves and Eyeball to the Nasal Accessory Sinuses. f, s, Frontal sinus; a, e, s, Anterior ethmoidal cells; p, e, c, Posterior ethmoidal cells; s, s, Sphenoidal sinus; o, n, Optic nerve; o, ch, Optic chiasm.

Nerve and Accessory Sinuses of the Nose, Lückhoff's Translation, 1909) and his findings have recently been confirmed by Loeb and others, who show that the sphenoidal sinus may be entirely replaced by this cell. Loeb's (A Study of the Anatomic Relations of the Optic nerve to the Accessory Cavities of the Nose. *Annals of Otol. and Rhin.*, June 1909) measurements of the ethmoidal labyrinth show a variation in the antero-posterior diameter of 22 to 54 mm., supero-inferior 17 to 59 mm. and lateral 9 to 28 mm. Onodi (The Oculo-Orbital, Intracranial and Cerebral Complications of Diseases of the Nasal Accessory Sinuses. *Laryngoscope,* November 1909) gives the average width of the anterior ethmoidal cells as 10 to 29 mm. The posterior cells extend into the area of the sphenoid bone and may vary from 8 to 40 mm. in width. They frequently extend upward, forming part of the superior orbital wall and the wall of the canalis opticus. In their extension backward they frequently reach the sella turcia and the fissura orbitalis superior and the foramen rotundum. Onodi described also what he terms a semicanalis ethmoidalis which is a membranous canal containing a group of veins and extending from the anterior ethmoidal foramen along the wall of the frontal sinus or anterior orbital cells to the anterior cranial fossa. Loeb (A Study of the Anatomic Relations of the Optic Nerve to the Accessory Cavities of the Nose. *Annals of Otol. and Rhinol.,* June 1909) has made an exhaustive study of the anatomical relations of the eye and optic nerve to the nasal accessory sinuses. His material consisted of twenty heads, decalcified and sectioned horizontally, the studies being made from sections containing the optic nerve in fifteen heads. By reconstructing these sections he shows graphically the exact relations of the various sinuses to the eye and optic nerve.

The definite detection of disease processes in the ethmoid labyrinth is perhaps the most difficult accessory sinus diagnosis which we are called upon to make. The tendency of infections in these cells is to run a latent course and they are so frequently diseased simultaneously with the other accessory sinuses that it is difficult to determine which symptoms of those present are to be referred to the ethmoid cells. The pain of an acute ethmoiditis or of an exacerbation of a chronic process is usually found at the root of the nose, although there is no typical headache or localization of pain in these cases. Disturbance of the sense of smell is frequently present, especially where secretion from the posterior ethmoidal cells fills the olfactory fissure. Many times the first symptoms are those of nasal stenosis, due to polypi formation.

The objective examination of these cases reveals pus in the middle or superior meatus with a tendency to crust formation. Various degrees of hypertrophy may be present, varying from flat circumscribed elevations to masses of polypi. Bare bone may be detected with the probe in the ethmoidal region, although one must not forget that the manipulations may have injured the delicate membrane overlying the cells.

As a rule infection occurs in one cell, chiefly the bulla ethmoidalis, or in several neighboring cells, the entire labyrinth rarely being involved. The anterior cells are more frequently infected than those posterior to the middle turbinal, their position exposing them to secondary infection from diseased frontal sinuses and antra.

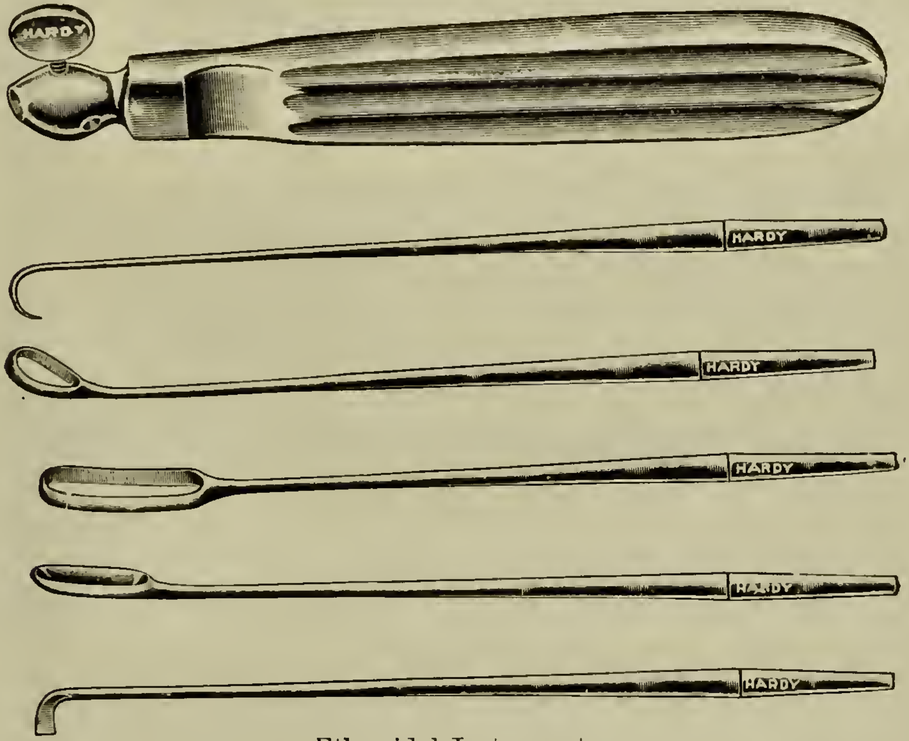
The anterior ethmoidal cells when infected may cause disease of the lacrimal sac or simulate it by perforation and a resulting abscess around the sac. An orbital abscess pointing low occasionally produces the same appearance. Differential diagnosis is unusually difficult but may be rendered certain by irrigating the sac through to the nose or locating ethmoidal disease in the nose and draining the cells. Ballenger (*Diseases of Nose, Throat and Ear,* 1909, p. 165) reports a case of ethmoidal suppuration which produced necrosis of the lacrimal bone and presented externally as a small tumor at the inner angle of the orbit which might easily have been mistaken for abscess of the lacrimal sac. There was considerable edema, the eye of the same side being entirely closed and the upper lid of the opposite eye swollen. The perforation occurred too far forward to involve the orbit. Ballenger (*ibid* p. 168) says, however, that in his experience the ocular symptoms of disease of the ethmoidal cells are rare compared to the number of cases of ethmoidal infection which he has observed. From their location, occupying almost the entire inner orbital walls, the ethmoidal cells are the most frequent source of orbital infection and probably act equally with the sphenoidal sinus as the source of optic nerve disease. The internal recti muscles lying as they do contiguous to the inner orbital wall are frequently involved in ethmoidal cell disease, presenting the muscle picture of insufficient converging power and lowered adduction with subjective symptoms of muscular asthenopia.

Pus originating in the posterior ethmoidal cells presents above the middle turbinal or is seen by posterior rhinoscopy in the choana. When seen in the latter position the pus may indicate either sphenoidal or ethmoidal disease or both, and it may be impossible to differentiate except by irrigating the sphenoidal sinus. Pus and crusts covering the vault of the pharynx practically always mean sphenoidal or posterior ethmoidal disease. Occasionally where the middle turbinal closes the middle meatus anteriorly, secretion from the anterior group of sinuses may drain backward simulating disease in the posterior cells or the secretion may be drawn backward by the patient in "hawking."

There are two types of ethmoidal infection, the open and the closed empyemas, the first type frequently passing into the second. In the first, pus is found draining into the nose, while in the other it remains shut up within the cells, where it may cause them to dilate, forcing the lamina papyracea outward into the orbit, producing proptosis of the eyeball and disturbance of the ocular muscles. Where the dilation is bilateral the so-called "frog-face" results. When the dilation takes place toward the nose it is seen filling the middle meatus or as a cystic middle turbinal. The appearance is that of a large polypus until a probe reveals the bony consistency of the wall. Where the secretion flows over the turbinals and forms crusts, atrophy results. The secretion which produces ozena or rhinitis atrophicans fetida undoubtedly originates from the mucous membrane covering the ethmoidal labyrinth, according to Hajek (*Nebenhöhlen der Nase,* 1903, S. 226). Where inspection of the middle meatus is rendered difficult or impossible by the position of the middle turbinal, the latter may be bent away from the lateral nasal wall until its attachment fractures. This is easily accomplished by Killian's long nasal speculum, which is introduced into the middle meatus and the blades forcibly separated. A small tampon is left in the middle meatus a few days until the fracture has healed sufficiently to retain the turbinal in its new position. In the opposite condition, where the middle turbinal produces pressure against the septum with reflex ocular symptoms, the Killian speculum is introduced between the septum and the turbinal and the latter fractured and forced outward against the lateral nasal wall, avoiding a turbinectomy and conserving functionating tissue.

Thorough drainage of the cells of the ethmoidal labyrinth may be accomplished intranasally or by one of the external methods. Where polypi and hypertrophies are found in the nose interfering with the drainage they should be completely removed with snare, punch-forceps or curettes. In some cases this will prove sufficient, especially if supplemented by some form of suction treatment applied for an hour daily. The galvano-cautery is a dangerous procedure in this condition, owing to the excessive and long continued reaction it produces, and should be avoided. The intranasal route to the ethmoidal cells is indicated in all except the most severe types of acute infection, with signs of orbital or cranial involvement, and in chronic cases complicated by disease of the adjacent sinuses.

While in many cases it will be found impossible to remove all of the diseased ethmoidal cells intranasally, yet the patient prefers to endure the excess nasal secretion rather than have an external operation. The chance of a disfiguring scar, especially in young girls, outweighs the advantages of the more thorough surgical procedure. These cases may then be considered satisfactory when they are relieved of pain, recurrences and excessive nasal discharge, and are safe from possible involvement of the neighboring ocular structures or the cranial cavity.

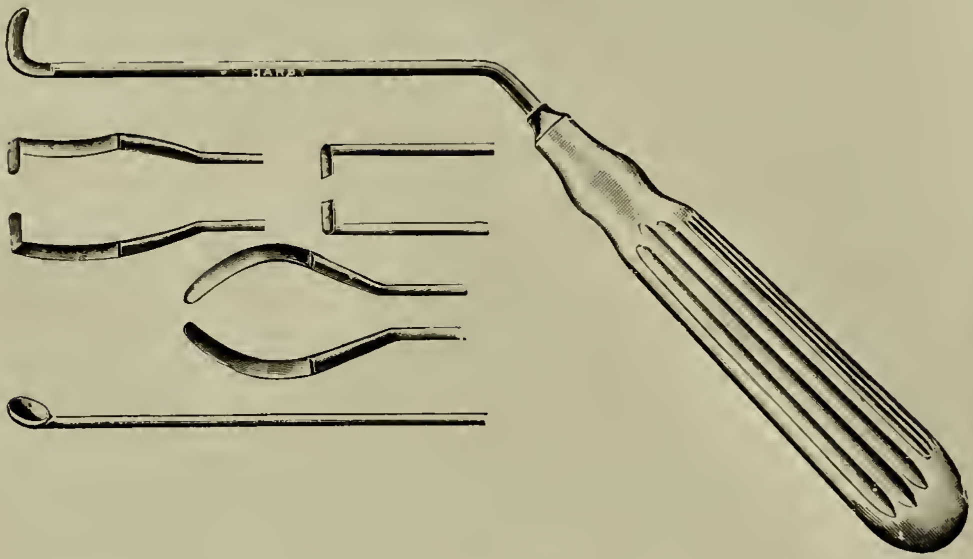


Ethmoidal Instruments.

1, Universal handle; 2, Coakley's antrum curette, long curve; 3, Fenestrated curette, sharp and long; 4, Curette; 5, Sharp hook; 6, Hajek's knife.

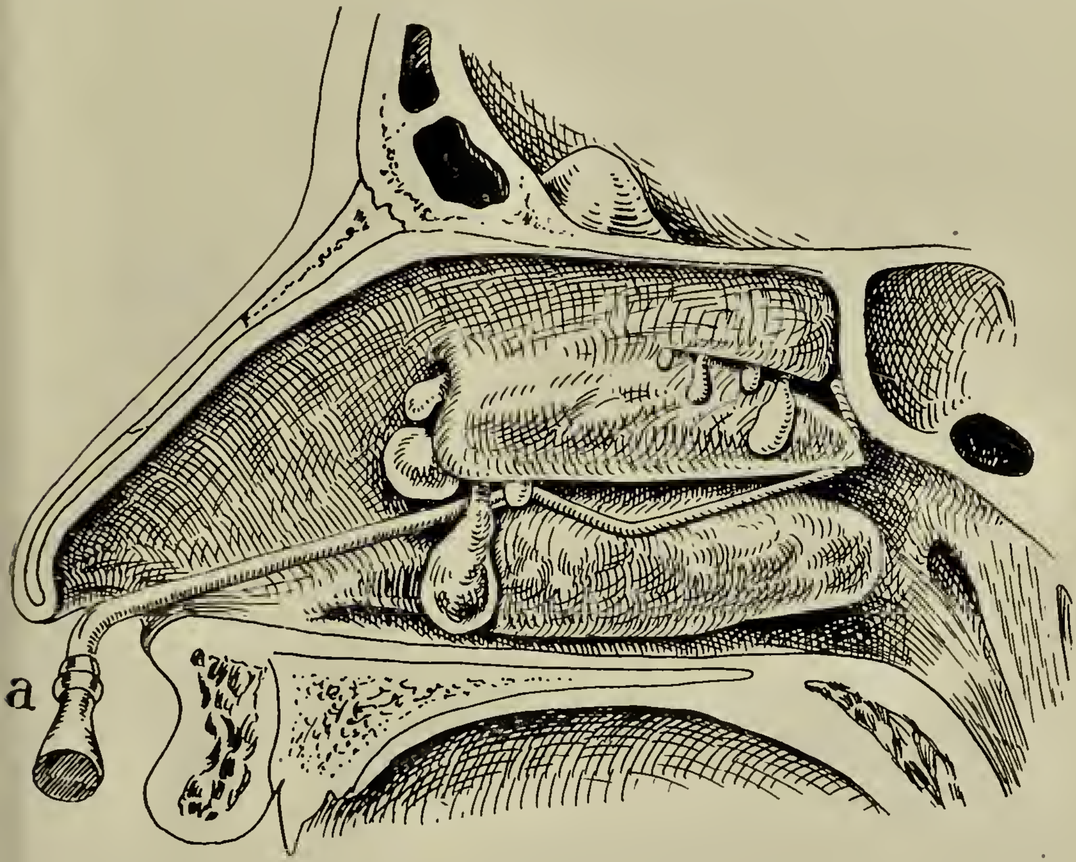
Axenfeld (Die Behandlung Orbitalen Mucocelen, besonders die endonasale Therapieusw, *Klin. Monats. f. Augenheil,* Oct. 1911, S. 494) prefers the endonasal route in all operations upon mucoceles of the accessory sinuses which invade the orbit. By removing a portion of the middle turbinal and then sufficient part of the ethmoid labyrinth to thoroughly drain the mucocele, a return to normal conditions in the orbit results. In the majority of cases, no deforming external operation is necessary and the functions of extraocular muscles and especially the pulley of the superior oblique have been conserved.

The first step necessary to reach the ethmoidal cells is the removal of a portion of the middle turbinal. The middle meatus is thus exposed and many times the location of secretion, crusts or flat hypertrophies will indicate the diseased cells. These cells may now be entered with one of Hajek's hooks or curettes or the Sluder knife and a portion of the wall cut or broken away. The removal of the wall may then be completed by some form of punch-forceps, such as the Myles or Grünwald. It may be necessary to do the operation in several sittings as the field is likely to be obscured by hemorrhage, interfering with the thorough removal of diseased tissue. Ballenger (*Diseases of the Nose, Throat and Ear,* 1909, p. 233) in 1905 devised a method for removing the ethmoidal cells and middle turbinal en masse. Owing to the fact that the ethmoidal cells have only three planes of attachment it is possible to remove a large part of the posterior ethmoidal cells and some of the anterior cells with the middle turbinal in one piece. The chief instrument used consists of a long blade, curved slightly on the flat, and having a shorter blade attached at right angles to the end of the first blade. After inducing anesthesia with powdered cocain the ethmoid knife is introduced into the nose with the short blade upward and passed backward through the middle meatus to the anterior sphenoidal wall, or until it engages the posterior end of the middle turbinal. The handle of the knife is turned horizontally across the opposite side of the face during this step of the



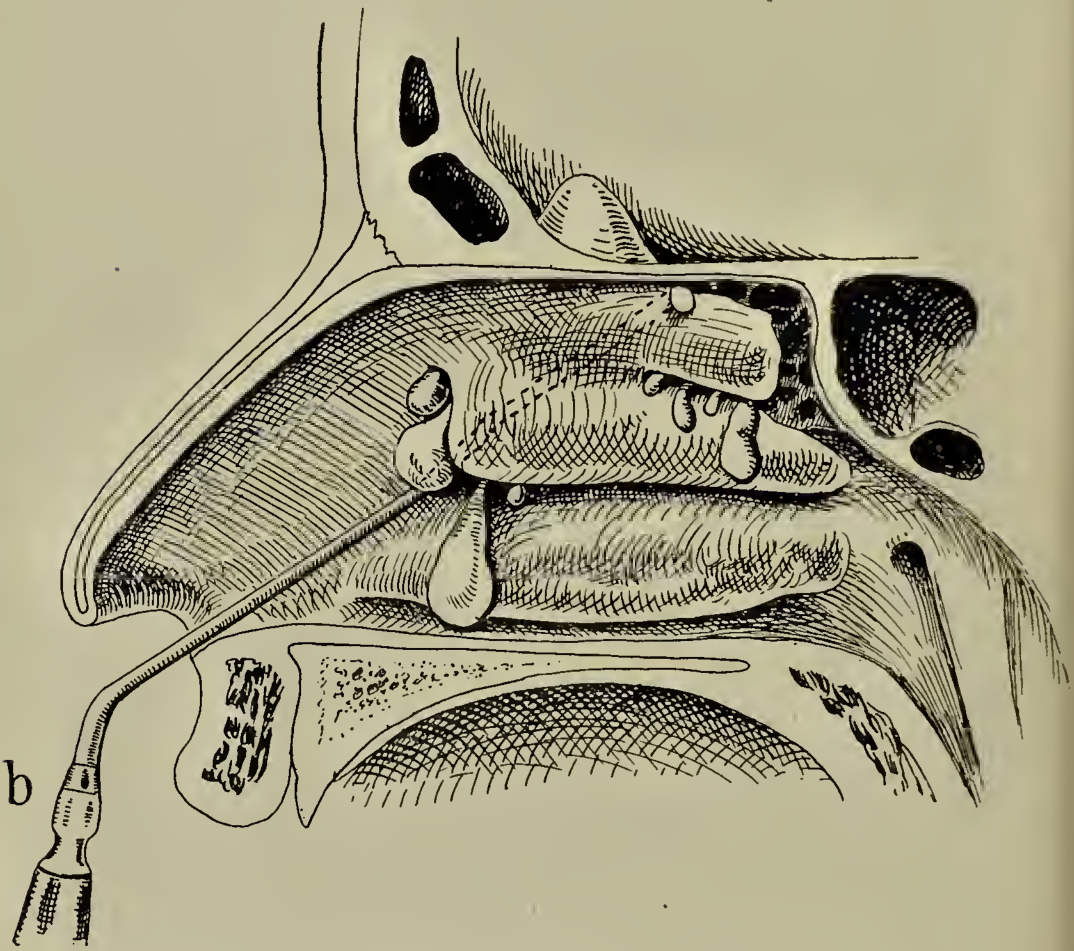
Ballenger's Set of Ethmo-Turbinal Knives and Sphenoid Curette.

operation. The short blade is now forced outward with a to-and-fro motion through the attachment of the ethmoid cells to the anterior wall of the sphenoidal sinus. The handle of the instrument is then rotated downward forty-five degrees until it lies directly in line with the nose. The short blade is then forced upward to the cranial plate, the long blade being in the middle meatus. Next, the blades are made to cut forward by rotating them back and forth in their axes, fracturing the ethmoidal cell walls and then cutting through the lining membrane. When the anterior attachment of the middle turbinal has been reached the knife handle is rotated upward almost to a horizontal position across the same side of the face, and the knife drawn forward and downward to complete the incision. The mass may now be removed with dressing forceps, the wound sponged dry and any remaining fragments of the cell walls removed with a curette. Where hemorrhage is excessive the region of the wound may be packed with a strip of gauze one and one-half inches wide impregnated with bismuth subnitrate powder. The gauze may usually be removed in 24



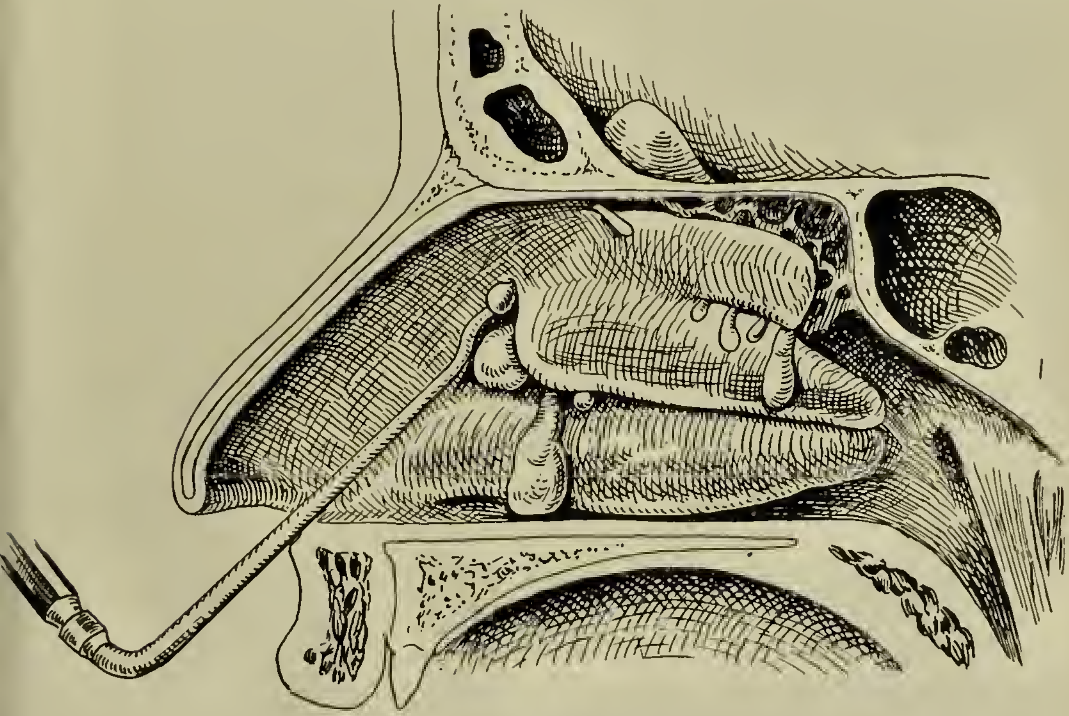
First Step of Ballenger Operation for the Removal of the Ethmoidal Cells with the middle turbinal. The ethmo-turbinal knife is shown in position at a.

hours and the wound treated daily with tampons of cotton saturated with a 10 per cent. aqueous solution of ichthyol or argyrol left in place twenty minutes. Ballenger finds this method of after-treatment superior to irrigations. He rarely packs the nose except for severe hemorrhage. If the patient is operated upon in the hospital and immediately put to bed the danger of hemorrhage is not great and packing may be dispensed with. The patient should be warned not to blow his nose as air may be forced into the orbital tissues, and if sneezing occurs the force of the sneeze should be lessened by "sneezing through the open mouth." Secretions may be gently aspirated backward into the throat. Ballenger has never observed orbital infection following operations upon the ethmoid in an experience covering over four hundred operations. He has never seen meningitis follow, as the cribriform plate of the ethmoid and the cranial plate of the frontal bone are not easily fractured.



Second step in the Ballenger Ethmoid Operation. The position of the knife as it cuts forward is shown at b.

External operations upon the ethmoidal cells. Hajek (*Nebenhöhlen der Nase,* 1903, S. 251) concludes after an extensive experience that it is almost impossible to bring about an ideal result with entire cessation of secretion by means of the endonasal methods of operating upon the ethmoidal cells. He has usually found that in spite of painstaking removal of cell after cell with the lining membrane, the secretion has persisted. In the more severe types of ethmoidal disease Hajek follows the method of Kuhnt which he quotes in full.



Final Step in Ballenger's Ethmoid Operation. As shown, the knife is turned to cut out at the anterior attachment of the middle turbinal.

The skin incision begins at the upper border of the internal palpebral ligament and is carried upward to the supraorbital margin. The periosteum is then carefully elevated, conserving the trochlea. Hajek continues the incision downward, carefully raising the lacrimal sac from its position, thus gaining sufficient space to easily reach the ethmoidal cells. (Other methods of operating upon the ethmoidal cells have been dealt with as a part of the various operative procedures upon the frontal and maxillary sinuses.) The external route is absolutely indicated where orbital cellulitis or abscess exists or where intranasal procedures have failed.

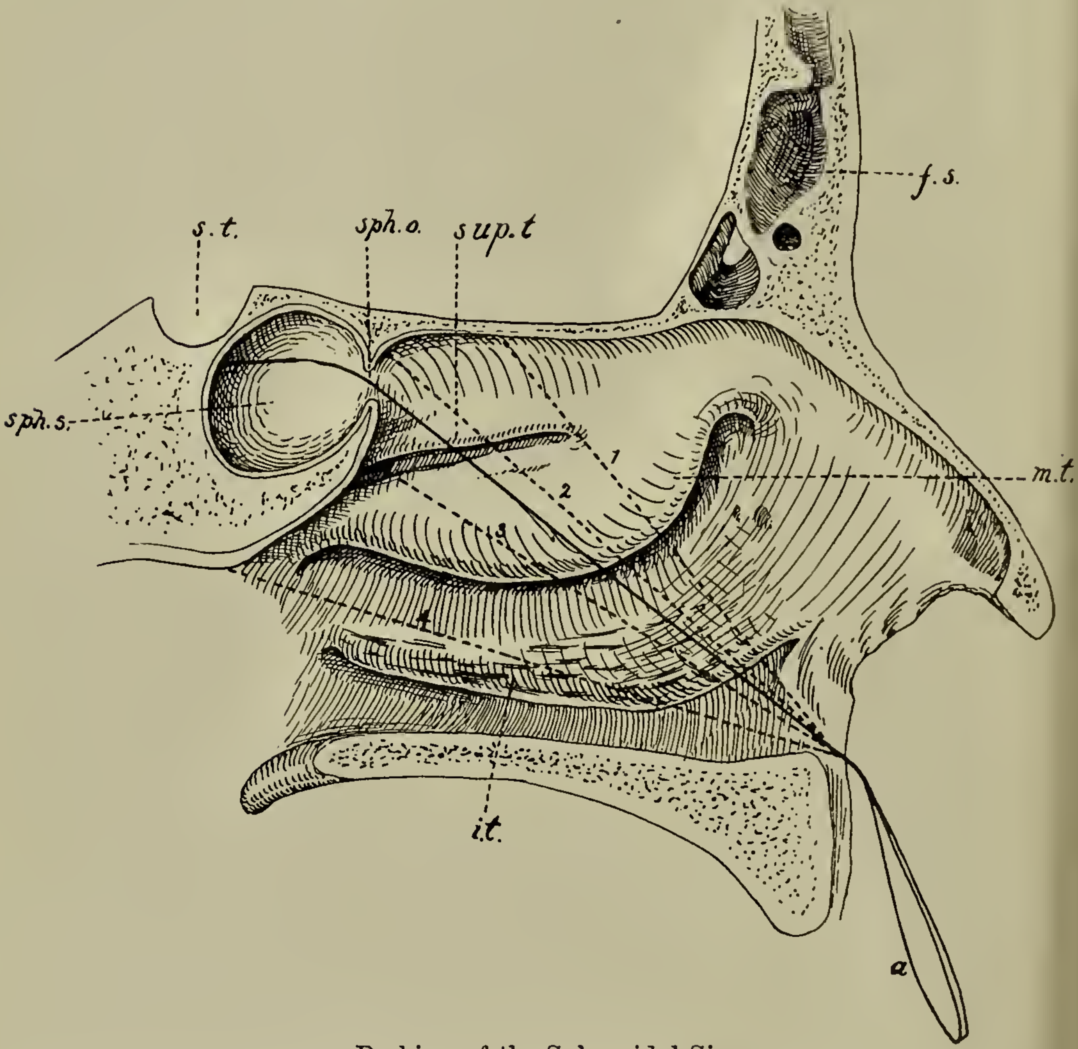
Sphenoidal sinus. The two sphenoidal sinuses occupy the central portion of the sphenoid bone. A bony septum separates the two air spaces and extends beyond the plane of their anterior walls, where it is known as the rostrum of the sphenoid. This rostrum joins the perpendicular plate of the ethmoid to form the supero-posterior portion of the nasal septum. Occasionally the septum between the cells is absent, making one large sphenoidal sinus, or it may develop obliquely producing asymmetry in the size of the cells.

The sphenoidal sinus has six walls. The superior wall presents toward the cranial cavity, carrying on either side the foramen opticum and farther back the sella turcica. On this wall lie the optic chiasm and the hypophysis cerebri. This upper wall is usually thin, the prominences of the foramen opticum and sella turcica or the canal of the internal carotid artery sometimes being found to project into the sinus. The lateral wall also borders the cranial cavity and is partly formed by the bony canal which supports the internal carotid artery and the cavernous sinus. The lower wall forms part of the roof of the nose and of the naso-pharynx and with the posterior forms the thickest of the sinus walls. Only exceptionally when the sinus is very large are these walls found to be thin. The anterior wall is the most important because it contains the ostium, and in its upper portion it is the thinnest wall of the sinus, and therefore the most approachable from a diagnostic and surgical standpoint. The ostium of the sphenoid usually lies above the middle line of the anterior sphenoid wall and opens into the recessus spheno-ethmoidalis formed by the attachment of the lateral mass of the ethmoid cells to the anterior surface of the sphenoid bone. The prominence of the middle turbinal prevents the ostium from being seen during the nasal examination, although this may be possible when the long Killian speculum is used to press the turbinal aside.

Loeb (A Study of the Anatomic Relations of the Optic Nerve to the Accessory Cavities of the Nose. *Annals of Otol. and Rhinol.* June 1909) found a great variation in the measurements of the thirty sphenoid sinuses studied. The antero-posterior diameter varied from 2 to 42 mm.; the supero-inferior from 4 to 38 mm. and the lateral from 2 to 35 mm. The smallest sphenoid sinus found measured 2 x 4 x 2 mm., the largest, 42 x 22 x 34 mm. The ostium in the anterior sinus wall was found to be midway between the floor and the roof of the cell in twenty of the thirty cells. One cell had its ostium within 2 mm. of its roof and another opened in the lower quarter of the anterior wall. In one-half the heads the optic chiasm was behind the sphenoid cells and no other cells were found in relation to the chiasm. The optic nerve measurements of the posterior portion in relation with the sinuses varied from 17 to 32 mm., slightly more than the length of the free portion of the nerve. Four of Loeb's cases were found to have their sphenoidal ostia at or above the level of the optic nerve, making it possible for decomposing pus to remain in contact with the common partition wall between the nerve and the sinuses. Onodi (The Oculo-Orbital, Intracranial and Cerebral Complications of Diseases of the Nasal Accessory Sinuses. *Laryngoscope,* November 1909) has observed one sphenoidal sinus 6 cm. in diameter. He has found this sinus in close relationship with one wall of the canalis opticus and with single segments of the sulcus opticus of either one or both sides. Either sinus may bound part of the canalis opticus and sulcus opticus of the opposite side. Extension of a disease process from the sphenoid to the cranial cavity by perforation of one of the cerebral walls may produce disturbance of one or both optic nerves and thrombosis of the cavernous sinus with disturbance of the sixth nerve, which lies within the sinus, and of the third, fourth and opthalmic division of the fifth nerves, which lie in its outer wall.

Francis and Gibson (The Sphenoidal Sinus as a Possible Etiological Factor in the Production of Retrobulbar Neuritis from an Anatomical Standpoint. Observations on Sixty Cases. *Trans. Amer. Acad. Ophthal. and Oto-Laryn.,* 1908) found in 60 dried specimens that the thickness of the sphenoidal wall in the optic nerve canal and in the region of the optic commissure were practically equal. The measurements showed that 33⅓ per cent. measured 0.25 mm. or less in thickness; 30 per cent. measured 0.50 mm. or less; 12⅔ per cent. 1 mm. or less; 3⅓ per cent., 2 mm. or less, and 12⅔ per cent., 2 to 5 mm. Orbital diverticula were found in 17 per cent. of the skulls examined. In many specimens the optic nerve canal presented a distinct rounded ridge on the wall inside the sphenoidal sinus, constituting an additional exposure to suppurative processes in the sinus. Demonstrable arteries were not found in the sinus lining membrane and the authors conclude that the sinus depends for its arterial supply upon the periosteum of the neighboring cavities. The only large artery, the spheno-palatine, passes outside the sinus and underneath it. They consider the character of the infecting organism to be more important than the thickness of sinus walls, streptococci and pneumococci rapidly destroying bone.

The more prominent subjective symptoms of sphenoidal sinus disease are headache, which is usually occipital, temporal or behind the eyeball, and postnasal discharge draining downward into the nasopharnyx. Where the secretion is profuse the patient complains of the dropping of secretion into the pharynx or the formation of crusts on the pharyngeal vault. The location of the pain is, however, very inconstant and many cases never experience headache. Mental disturbances which are frequent in disease of all accessory sinuses are most pronounced in sphenoidal disease. The most prominent mental symptoms are lack of concentration, loss of memory, depression, hypochondriasis and neurasthenia. Mild attacks of sphenoidal inflammation may occur with each attack of acute rhinitis until finally the process becomes chronic, with almost constant secretion draining postnasally. It is frequently impossible to differentiate between infection of the posterior ethmoidal cells and that of the sphenoidal sinus, and they are very often involved simultaneously. Objectively, secretion

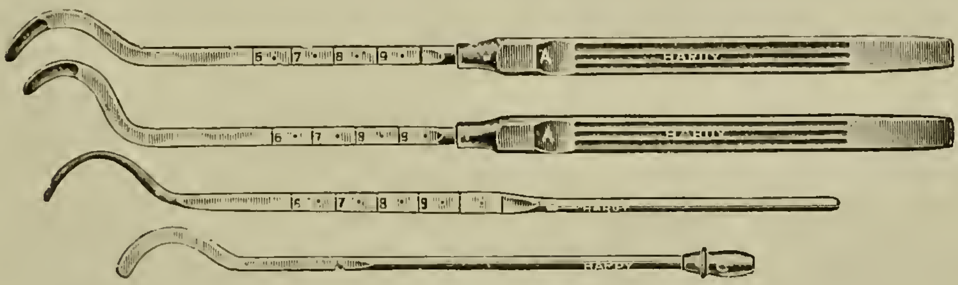


Probing of the Sphenoidal Sinus.

Dotted lines show possible erroneous directions of the probe. Black line shows correct direction. sph, s, Sphenoidal sinus; s, t, Sella turcica; sph, o, Sphenoidal ostium; sup, t, Superior turbinal; f, s, Frontal sinus; m, t, Middle turbinal; i, t, Inferior turbinal; a, Probe. (After Hajek.)

from an infected sphenoidal sinus may be seen by anterior rhinoscopy, flowing downward from the olfactory fissure or, as more frequently happens, with the aid of the post-nasal mirror, it may be seen draining over the posterior end of the middle turbinal or forming a crust on the vault of the pharynx. Occasionally a long string of secretion may be seen adhering to the posterior border of the septum.

After removing all nasal secretion with irrigations of warm physiological saline solution and shrinking the turbinal tissue with cocain 4 per cent. and suprarenalin 1 to 1,000, fresh secretion may be seen draining downward into the choana. This is probably sphenoidal in origin as very little secretion drains from the posterior ethmoidal cells after the patient has been in the erect position for a few hours. Bending the head forward to place the sphenoidal ostium at the lowest point of the cell facilitates the outflow of secretion. If the findings are negative the suction apparatus may be applied for five minutes and the patient re-examined, when a string of fresh secretion may often be seen hanging downward over the end of the middle turbinal or against the septum posteriorly. The suction treatment may be applied several times if the first attempts are negative.



Set of Sphenoidal Instruments.

a, Knives; b, Probe; c, Cannula. (Andrews.)

The middle turbinal may show hypertrophic changes due to the irritation from the sphenoidal secretion, but in uncomplicated cases polypi are seldom seen. The olfactory fissure is frequently almost closed by the swelling of the middle turbinal, its location being marked by dried secretion, which when wiped away reveals the thick pus which fills the fissure. After cleansing and cocainizing the nose it may be possible to reach the ostium of the sphenoidal sinus by means of a silver probe curved slightly downward at the tip. The probe is held anteriorly against the inferior nasal spine and passed between the septum and the middle turbinal, crossing the latter at its middle. When it has passed into the nose seven cm. it should reach the anterior sphenoidal wall in the neighborhood of the ostium. The distance varies in different sized heads, but the direction of the probe is always in the same line, which is known as the line of Zuckerkandl (*Normale u. Pathologische Anatomie der Nasenhöhle,* 1893). The ostium lies usually in the upper half of the anterior wall, and in many cases may be easily probed in the manner just described, or by means of Andrew's curved sound. Should the opening lie deep within the recessus spheno-ethmoidalis, however, it may be impossible to reach it without resecting the posterior portion of the middle turbinal and possibly one or more of the posterior ethmoidal cells also. When the tip of the probe has reached a point 7.5 to 8 cm. from the inferior nasal spine in small heads it is safe to say that it has entered the cell, but in larger heads the distance will vary from 8.5 to 10 cm. In some instances the anterior sphenoidal wall may be exposed by forcing the middle turbinal outward with the long Killian speculum. When the ostium has been located and all secretion removed from the nose, a small coin-silver cannula may be bent to the curve already found necessary for the probe and the cell irrigated with physiological saline solution to determine the presence of secretion.

It is sometimes difficult to differentiate between empyema of the sphenoidal sinus and that of the posterior ethmoidal cells, as the pus appears in the same area. The two conditions usually occur together, however, as it is almost impossible for pus to drain for any length of time from either region without infection of the other. The diagnosis may be made positive by irrigating the sphenoidal sinus. If pus is found after previously cleansing the olfactory fissure and this can be confirmed by several irrigations, sphenoidal disease is established. After cleansing the sphenoidal cell the ostium may be plugged with a strip of narrow gauze such as Beck uses for packing the external auditory meatus. If pus is found on the gauze after a few minutes it is safe to assume that one or more of the posterior ethmoidal cells is the source.

A rare complication may occur in case a double maxillary sinus is present, as the ostium of the posterior division of the double cell is usually in the olfactory fissure. This condition may be detected by excluding the sphenoidal sinus by irrigation and plugging its ostium. If pus appears its source may be traced by a probe which will pass several cm. into the antrum but less than 1 cm. as a rule into a posterior ethmoidal cell. The eye symptoms aside from orbital cellulitis or abscess with proptosis are in great measure due to optic nerve involvement.

The optic nerve changes at the disc in sphenoidal disease vary from a slight edema to an active papillitis, the latter is comparatively rare, however. The subjective symptoms are dimness of vision or absolute blindness in the affected eye and unilateral headache increased by stooping, by a heavy meal or by alcoholic drinks. The menstrual period is usually accompanied by an increase in the headache. Vertigo and nausea accompany the severe pain which tends to recur at relatively the same hour each day during the progress of the attack. The patient may be almost delirious with the pain and pressure headache—not relieved by drugs—or may lose his ability to concentrate his mind on any one thing or to think clearly. The pain frequently occurs during the night, as the recumbent position induces turgescence of the erectile turbinal tissue, especially in the lowermost side of the nose. Edema about the disc or between it and the macula is common and with it is usually noted dilatation of the retinal veins. The vision is usually lowered in proportion to the extent of the optic nerve involvement and in cases where it is not appreciably lowered for the usual tests, the reduction of the illumination of the test types or the use of the Bjerrum test cards as suggested by Posey (The Ocular Symptoms of Affections of the Accessory Sinuses of the Nose, *Trans. Sec. of Ophthalmology, A. M. A.,* 1905) will detect the difference between the two eyes.

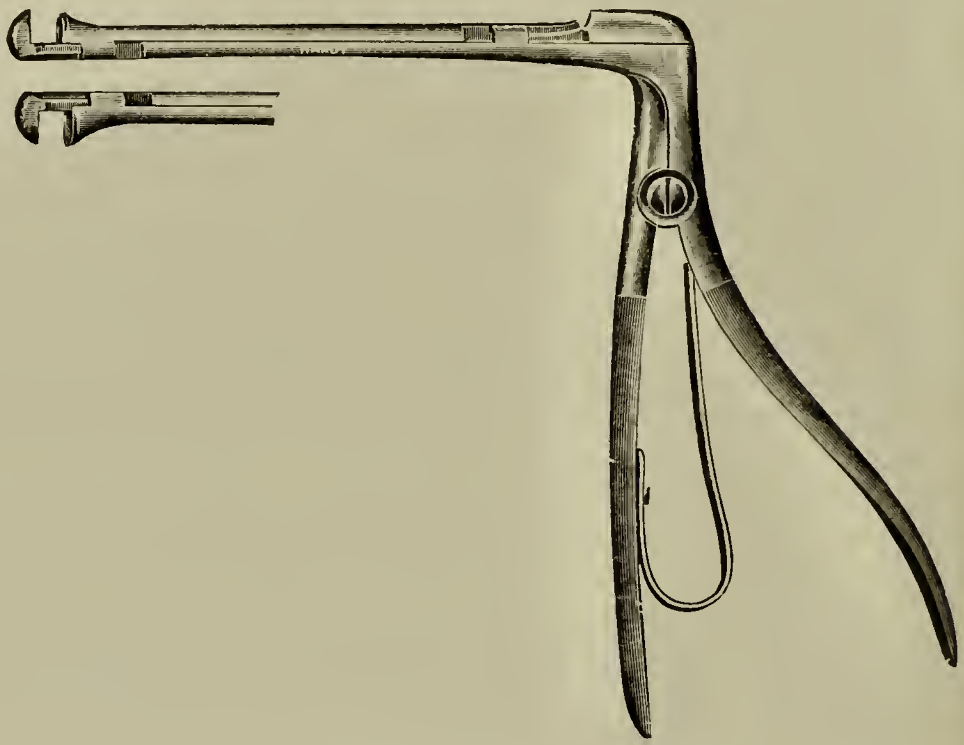
Relative central and paracentral scotomata are frequently to be found, especially when a small red test object of 1 to 2 mm. in diameter is used.

Other sources of possible toxic eye disturbance should always be excluded, such as alcohol and tobacco, syphilis and intestinal autointoxication.

New growths practically never produce optic nerve changes unless they break through the cell walls and involve the orbit.

Hysteria and neurasthenia frequently manifested in sinus disease should be excluded as a cause of the lowered vision. Paresis of one or more of the ocular muscles has frequently been noted.

In some cases it will be possible by treatment to relieve the subjective symptoms and bring the secretion to an end by irrigations followed by drying the cell with compressed air and insufflating xeroform powder. Where this does not suffice it becomes necessary to enlarge the ostium. Hajek (*Nebenhöhlen der Nase,* 1903, S. 285) has devised a number of sharp hooks and curettes (see the figure) for this purpose which fit a universal handle. The Sluder knife (see the figure) may also be used for this operation. The sharp hook or angle knife is passed into the ostium and pulled forward and downward through the sinus wall and then reintroduced and the wall cut through at each side of the opening. The fragments may now be removed with forceps and the wound enlarged with cutting forceps to any extent. Should the lining membrane appear red, edematous and discolored or granulations and polypi be present, they may be cautiously removed with a small curette. This procedure may well be postponed to a later sitting, however, as the increased drainage and after-treatment will frequently result in the return to normal of the greater part of the lining membrane.



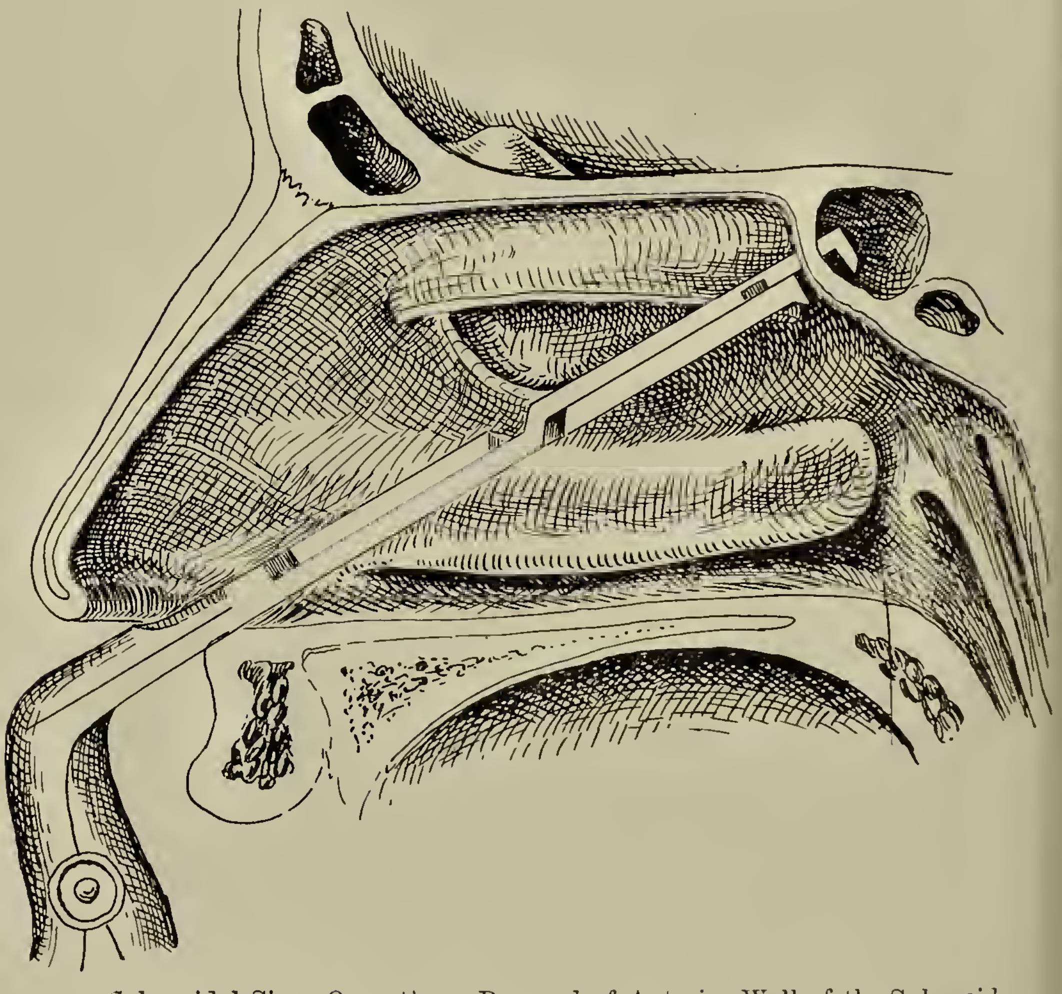
Hajek Sphenoid Punch.

The curetting of the sphenoidal sinus is not devoid of danger, the carotid artery lying free in the cell in ten per cent. of the cases and the thin bone walls offering but slight protection to the important surrounding structures. Emerson (Report of a Fatal Operative Case Showing Developmental Absence of the Outer Sphenoidal Wall and in Its Place a Large Vein Communicating Directly with the Cavernous Sinus. *Laryngoscope,* Jan. 1909, p. 43) reports a dehiscence in the outer wall of the sphenoidal sinus which was occupied by a large varicose vein communicating with the cavernous sinus. Death resulted from intracranial hemorrhage following injury to this vein during curettage of the sphenoidal sinus walls.

The after-treatment consists of irrigations, applications of a 10 per cent. solution of argyrol or ichthyol, 1 per cent. silver nitrate or zinc chloride or insufflations of xeroform powder.

The endonasal operation suffices for all uncomplicated cases of sphenoidal disease, the more radical operations by way of the frontal sinus, orbit and antrum of Highmore being reserved for cases of combined empyema. Curtis (The Sphenoidal Sinus and Its Surgical Relationship. *Trans. Amer. Laryn., Rhin. and Otol. Soc.*, 1904, p. 103) operated on a case of sphenoidal abscess by enlarging the ostium with a long-shaft trephine after removal of the middle turbinal. This was done in 1886 and reported (*Amer. Med. and Surg. Bull.*, Vol. 11, page 1516), and Curtis believes it to be the first operation of the kind. He never packs the sinus and is very cautious about even simple irrigation as it occasionally causes much pain and nausea. The posterior ethmoidal cells are usually also infected and require removal, for which purpose he employs the probe pointed dental drill devised by Balance. Hajek (Zur Diagnose und Intranasalen Chirurgischen Behandlung der Eiterungen der Keilbeinhöhle und des hinteren Siebbenlabyrinthes., *Archiv. f. Laryn.* 1904, Bd. 16, S. 105) has modified his sphenoidal sinus operation by the use of cutting forceps in addition to the various sharp hooks. The forceps are as strong as is possible in instruments which must be narrow enough to pass into the olfactory fissure. The forceps come in pairs, one with cutting jaws upward to remove the wall above the ostium and the other with jaws downward to remove the wall below. He finds that the average proportion of the pars nasalis of the anterior sphenoidal wall is 3 and the pars ethmoidalis 5, allowing plenty of room for intranasal operations. Hajek uses his set of hooks to remove the posterior ethmoidal cells, thus uncovering the entire anterior sphenoidal wall. Local or general anesthesia is used, both requiring adrenalin tampons in the olfactory fissure to insure as bloodless a field as possible. The hook with point down to avoid possible injury of the cribriform plate is passed upwards and backwards above the middle turbinal until it reaches the anterior sphenoidal wall, when the point is rotated outward cutting into the ethmoidal cells. By pressing the handle toward the septum the hook passes more deeply into the cells and by a strong pull is made to cut through them, taking with it a part of the attached middle turbinal. The fragments may then be removed by forceps. Three instances of severe secondary hemorrhage on the seventh day have been reported by Gleitsmann (*Trans. Amer. Laryn. Assn.* 1895) and by Hajek (*Archiv. f. Laryn. and Rhin.* 1904, Bd. 16, p. 125) and Hinkel quoted by Hajek. Anterior and posterior tampons controlled the hemorrhage.

Thorough after-treatment is necessary to prevent the great tendency to closure of the wound. The granulations are cauterized every 5 to 8 days, a small area being treated at each sitting to avoid reaction. Too extensive cauterization produces an inflammatory reaction of the entire lining membrane of the sphenoidal cavity with extensive edema producing an appearance as though the cell were filled with polypi, which, however, subsides in a few days. This is also true of the ethmoidal cell membrane. Removal of diseased tissue may then very well be left to a future sitting when the reaction has subsided and such tissue is more easily identified. Occasionally there occurs a muco-purulent secretion after the healing seems complete, but this seldom persists more than a few days and is probably a fresh infection, which the operation naturally will not prevent. As the after-treatment requires many weeks the external methods advo-



Sphenoidal Sinus Operation. Removal of Anterior Wall of the Sphenoid Sinus with the Hajek Forceps. (After Ballenger.)

cated would require the leaving of an external open wound for a length of time that is impossible, unless the after-treatment could be carried out intranasally by removing the nasal wall of the ethmoid labyrinth at the time of the radical operation. Winkler (*Archiv. f. Laryn.* 1895, Bd. III, S. 391) mentions an intranasal operation for an extensive removal of the anterior sphenoidal wall after removal of the middle turbinal and ethmoidal cells, but gives no details. Killian (*Verhandlungen der Deutschen Otolog. Gesellschaft,* Heidelberg, 1900) suggests that the sphenoid be reached by dilating the middle meatus, opening the bulla and thence to the posterior ethmoidal cells and anterior sphenoidal wall. Details of the actual operation are lacking in this report. Hajek (*Archiv. f. Laryn.,* Bd. 16, 1904) finds that the sphenoidal ring contains a posterior ethmoidal cell in about 25 per cent. of the specimens examined by him. He detected disease in this cell when pus continued to flow downward into the nasopharynx after irrigation of the sphenoidal sinus and succeeded in passing a probe into its ostium. Berens (Fourteen Cases of Multiple Sinusitis Operated upon by the Maxillary Route. *Trans. Amer. Laryn., Rhin. and Otol. Soc.,* 1904) states that he does not know to whom credit belongs for the so-called antral route to the sinuses as Jansen, Luc and Boenninghaus described it at about the same time.

The operation is performed under ether anesthesia and with the aid of an electric headlight, as follows: The jaws are held apart by a mouth-gag inserted on the well side. The choana of the diseased side is tamponed by a post-nasal tampon of cotton. To prevent blood reaching the pharynx from the mouth, a gauze sponge is held by dressing forceps between the jaws and the cheek of the affected side. The cheek is retracted by a blunt retractor held by an assistant. The tongue is held forward by a silk ligature passed through it. This prevents delays by the tongue falling backward. An incision extending from the posterior end of the alveolar process to the anterior border of the canine fossa is made through the mucous membrane and periosteum, just below and parallel with the attachment of the cheek. A periosteal elevator is then used to free the anterior and lateral convex surface of the antral wall from its periosteum and soft parts. The bleeding is controlled by pressure with gauze. The antrum is opened by a chisel sufficiently to allow of a rongeur, which is then used to remove the outer wall of the antrum, anteriorly to its junction with the internal wall, inferiorly to the floor, superiorly almost up to the infraorbital canal and posteriorly along the external wall to just behind the anterior border of the masseter muscle. This part of the operation is nearly bloodless unless the lining membrane of the antrum is wounded. The membrane is then incised and the cavity inspected. After completely removing the lining of the antrum with a large, sharp curette, the bony internal or nasal wall is removed anteriorly to the junction with the external wall, posteriorly to its junction with the posterior wall, and inferiorly to the floor of the antrum with the same instrument, care being taken to preserve all of the membrane on the nasal side. The superior part of this wall, which is formed by the ethmoid cells, is removed with the sharp spoon, as are all of the ethmoid cells and also the middle turbinate. A superior turbinate process is sometimes present and is removed. The opening to the sphenoid sinus is now plainly visible. As much as possible of the anterior wall of the sphenoid is removed laterally, and always to its floor, with a sharp curette, as is the diseased tissue lining the cavity. During these various procedures the cavity is frequently dried with gauze soaked in 1 to 1000 adrenalin solution, which usually controls the hemorrhage, at times quite troublesome. The upper part of the membranous wall of the antrum usually is destroyed, but its lower two-thirds is preserved intact. The inferior turbinate bone is freed from its membrane piecemeal, both with the rongeur and the sharp spoon, leaving the mucous membrane in a long strip attached anteriorly and posteriorly. This procedure is facilitated by the insertion of the small finger into the naris, which affords counter pressure.

After the wound is thoroughly cleansed, the remnants of the nasal mucous membrane, consisting of tissue from the inferior turbinate and from the lower two-thirds of the nasal wall, are utilized as follows: That remaining from the wall is freed from its anterior attachment and is drawn into the cavity of the antrum, covering in large part the anterior wall and part of the floor. It is anchored by a stitch to the superior lip of the wound in the mouth. The mucous membrane of the inferior turbinate is divided at the posterior end of its anterior third, and the posterior flap thus formed is placed along the floor of the antrum and anchored by a stitch to the inferior lip of the wound; while the anterior flap of turbinate mucous membrane is anchored around the "anterior angle." The result is that the lower and anterior part of the antrum is fairly well lined with a functionating mucous membrane. The whole wound, from the anterior of the sphenoid sinus to between the lips of the oral wound, is packed with iodoform gauze. The oral wound is not stitched.

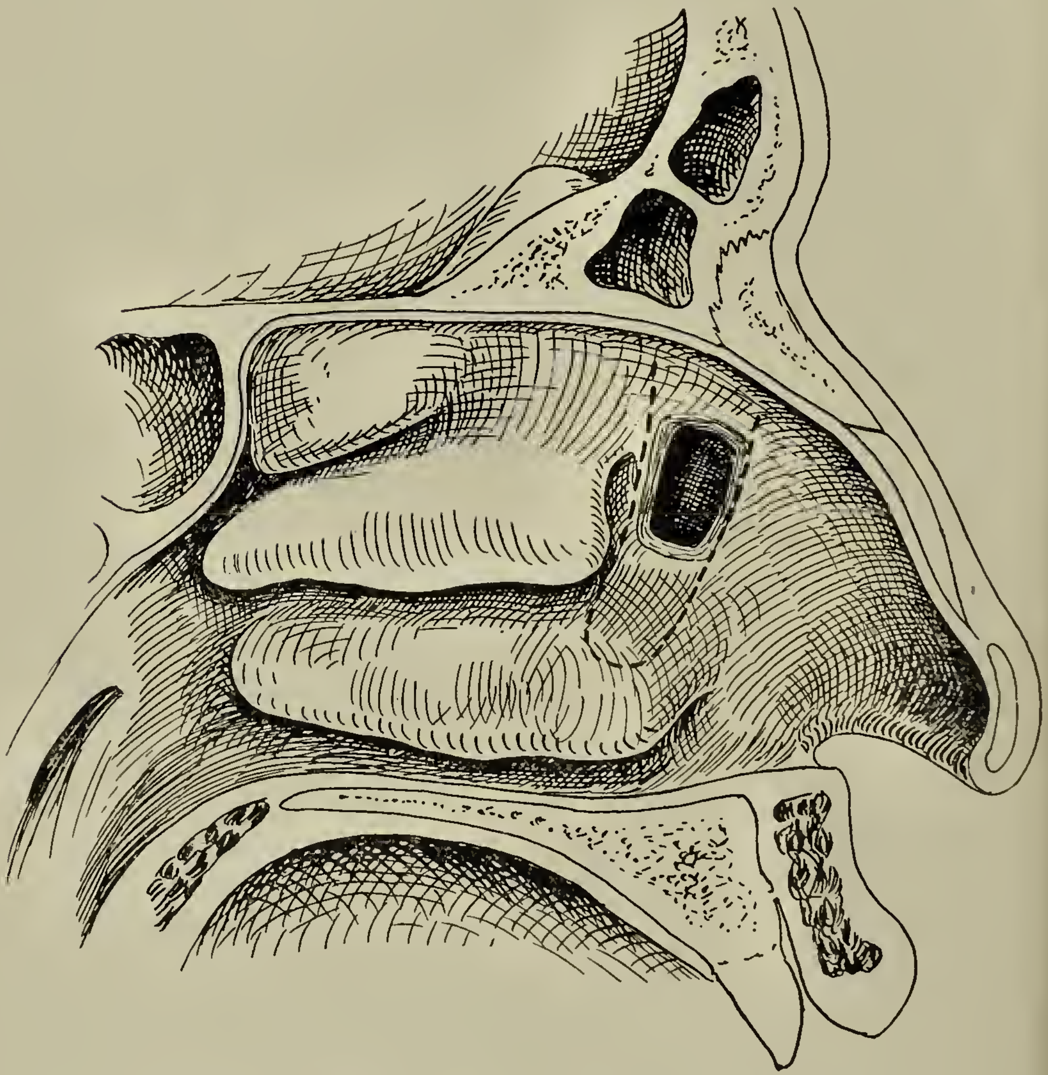
Stitching of the oral wound, as advised by Jansen, was not practised in any of the cases, owing largely to the uncertainty of the wisdom of the procedure; and Berens states that it was certainly a great comfort to be able to see the process of repair and to know beyond a doubt just what was taking place in the operated area.

In the first few cases operated upon the packing was carried much longer than in the later cases, which were packed at the time of operation, the packing being removed in three to four days and not reinserted. The highest temperature recorded in any case was 103½° and this was attributable to other causes; in all of the other cases 100½° was the maximum.

Opiates were administered in nearly all of the cases for the pain immediately following the operation. After the first 24 hours iced cloths were found sufficiently efficacious to control the pain. Each patient, with two exceptions, was in the hospital one week only, and in the cases of the males they resumed their customary vocations in two weeks.

Owing to its close relation to the lateral and superior walls of the sphenoidal sinus, the cavernous sinous may here be considered. Thrombosis or thrombophlebitis of the cavernous sinus may occur directly in disease of the sphenoidal or posterior ethmoidal cells or indirectly from disease of any of the nasal accessory sinuses, orbital abscess, tonsil infections, etc., by way of the venous channels which drain the above mentioned areas, carrying the infectious material into the cavernous sinus.

Langworthy (Thrombosis of the Cavernous Sinuses: Report of Four Cases, *Boston Med. and Surg. Jour.*, April 1907, p. 528; and A Proposed Operative Measure for Thrombosis of the Cavernous Sinus, *Laryngoscope,* July 1906) reports several cases of thrombosis of the cavernous sinuses, secondary to mastoid infection, showing paralysis of external recti muscles, dilated pupils, exophthalmos and lid edema, and later choked disc. Hartley and Krause (*International Text-Book of Surgery,* Vol. 8, p. 866) quoted by Langworthy, reach the cavernous sinus by way of an osteoplastic flap in the temporal region. The dura mater is then loosened from the squamous and petrous portions of the temporal bone until the second and third divisions of the fifth nerve appear, when the sinus will be located above the second division of the fifth nerve, the first division lying in the outer wall of the sinus itself. Langworthy proposes to reach the cavernous sinus through the inner orbital wall and sphenoid. The usual curved frontal incision through the eyebrow and downward along the nasal bone is lengthened downward. The eye and orbital contents are retracted from the field and the inner orbital is removed together with the nasal bone of that side. The ethmoid cells with the middle and superior turbinates are next removed with a curette, exposing the anterior wall of the sphenoidal sinus. This wall with the portion of the lateral and superior wall upon which the cavernous sinus rests is next removed and the sinus opened with a knife and blunt dissector. The external wound is closed and after-treatment may be carried out through the nose.



Intranasal Window Resection of Nasal Duct (After West).

Langworthy has also reached the cavernous sinus by means of a strong curette having a mark on the shank 3¼ inches from the tip. The curette is passed back through the nose to the posterior pharyngeal wall and then withdrawn in contact with the floor of the sphenoidal sinus. Just above the juncture of the anterior wall and floor of the sphenoid the curette is forced through the anterior wall upward and backward through the roof and into the cavernous sinus, where it joins the circular sinus. He proposes to prepare for ligation of the carotid in case of injury to that artery by passing a ligature around it in the neck and leaving it untied. These operations have been carried out upon the cadaver successfully and the latter upon a patient who had been dead an hour from cavernous sinus thrombosis. The curette reached the sinus accurately and by rotating it the opening was easily enlarged and when withdrawn the curette contained pus. The sinus opening was confirmed by removing the skull cap and brain and opening the sinus from above, when pus was seen draining into the sphenoid through the curette wound.

Luc, according to Langworthy, has suggested reaching the sinus at the angle obtained by opening the antrum of the opposite side and so passing obliquely through the sphenoid of the same side into the cavernous sinus. The operations, while presenting the probability of injury to the optic nerve and carotid artery, offer some hope of relief to a patient who is practically certain to die and in whom the optic nerve and globe have already been irreparably injured.

Reference may be made at this point to the intranasal operation upon the lacrimal duct from its close relation to the antrum of Highmore. The various methods previously used in a few instances have consisted in resecting the anterior portion of the inferior turbinal and then cutting away the nasal wall of the duct. This has meant the loss of functionating tissue.

West (A Window Resection of the Nasal Duct in Cases of Stenosis, *Trans. Amer. Ophthal. Soc.*, 1910, p. 654) has devised an intranasal method of opening the lacrimonasal duct which he considers superior to former methods which required the partial resection of the inferior turbinal. A No. 4 probe is passed through the dilated punctum as a guide and then by means of small bevel-edged chisels, a portion of the lacrimal bone and superior maxilla is removed just above the inferior turbinal, forming a large opening in the duct. It is necessary to use care to avoid opening the maxillary sinus. Local anesthesia is used. Strictures below the window opening are unimportant as tears will drain through the window, while any stenosis high up in the duct is removed by the operation. The report is a preliminary one and details are lacking regarding the future of such cases. The work was done in association with Robert L. Randolph, who thinks highly of the method. It would seem that such a method gives promise of reaching the point of stenosis directly and of retaining the integrity of the delicate lacrimal apparatus.

A very satisfactory method has been devised by Toti, although it has the disadvantage of being an external operation requiring general anesthesia and leaving a scar.

Toti's operation. (*La Clinica Moderna,* No. 35, 1904.) The skin incision is elliptical 3 to 3½ cm., the concavity toward the internal canthus of the eye and 3 mm. outside the attachment of the tendon of the orbicularis. The incision begins above at the junction if the posterior lacrimal crest with the orbital process of the frontal bone, curving downward and toward the nose until beyond the tendon, when it again curves outward and downward to the level of the beginning of the bony lacrimal duct. The periosteum is raised on that side of the incision toward the eye only and after uncovering the lacrimal fossa this area is swabbed dry and covered with tampons of adrenalin and cocain 20 per cent. The nose is next anesthetized. The bony margin of the orbit at the border of the lacrimal fossa is first resected, then the bony floor of the lacrimal fossa itself is cut away posteriorly to the posterior crista lacrimalis, inferiorly to the lacrimonasal duct and superiorly to the curved elongation of the posterior crista lacrimalis. The nasal mucosa should be preserved intact. If ethmoidal cells are encountered in opening into the nose they should be cut away. The nasal mucosa is forced into the bony opening after the bony margins have been smoothed off, and an opening made to correspond with the posterior wall of the lacrimal sac. After cutting away the sac wall the sac is replaced and the skin sutured. The nasal mucosa is now held in position against the lacrimal sac by tampons of iodoform gauze. In this way the bony walls of the lacrimo-nasal wound are covered with mucosa and healing without constriction of the opening is assured.

In the after-treatment the nose is undisturbed for 3 or 4 days. when the tampon is removed, crusts and secretion are wiped away and bismuth powder insufflated. The skin sutures and external dressings are removed on the 7th or 8th day.

Török (Dacryocystorhinostomia [Toti's operation,] *Archives of Opthal.,* May 1911, p. 237) reports 9 cases of chronic purulent dacryocystitis operated upon by the method devised by Toti. Of these 6 resulted in perfect tear drainage, 2 others experienced moderate tearing out of doors or where some irritation produced an excess of tears and in one case there was tearing, but no secretion or condition equal to that resulting from extirpation of the sac.

Salus (*Klin. Monats. f. Augenheil,* July 1911, S. 54, "Erfahrungen über Toti's Dakryozysto-rhinostomie") reports 29 cases, of which 13 were perfect results, no epiphora was present even upon irritation of conjunctiva, the lacrimal system was freely open to syringing and probing, and fluorescein solution dropped into the conjunctival sac was seen almost instantly in the nose. In 11 cases there was no epiphora under ordinary conditions, but conjunctival irritation showed insufficient drainage and fluorescein solution either could not be detected in the nose at all or only after considerable time had elapsed after dropping it into the conjunctival sac. In the remaining 5 cases no improvement followed the operation.

Contraindications to operation are slit canaliculi and serious nasal infections such as syphilis or atrophic rhinitis.

An unusual but well defined condition is disease of the spheno-palatine, or Meckel's, ganglion.

Sluder (The Rôle of the Spheno-Palatine [or Meckel's] Ganglion in Nasal Headaches, *N. Y. Med. Jour.*, May 23, 1908) first described this syndrome in 1908 and since that time has presented further evidence in substantiation of his position.

The spheno-palatine ganglion lies in the pterygo-palatine fossa in the region of the spheno-palatine foramen. The pterygo-palatine fossa is bounded above by the body of the sphenoid and the orbital process of the palate bone; anteriorly by the posterior wall of the maxillary antrum; posteriorly by the base of the pterygoid process, and the lower posterior of the great wing of the sphenoid; medially by the vertical plate of the palate bone.

The position of the ganglion as shown in Sluder's specimens is frequently within 2 mm. of the spheno-palatine foramen, though it may be as far removed as 7 to 9 mm. and it lies high up in the fossa. The bony boundaries of the pterygo-palatine fossa are of very thin bone in a majority of cases and are directly related to the maxillary sinus in front; the sphenoidal sinus above and medially to the lateral nasal wall which is directly exposed to the drainage from suppurating sphenoidal or posterior ethmoidal cells.

A point of great practical interest is the location of the spheno-palatine foramen which lies in the lateral nasal wall just behind and above the posterior tip of the middle turbinal. This foramen is the guide to the position of the spheno-palatine ganglion which lies always in the same plane as the foramen. The close relations anatomically and clinically between the pterygo-palatine fossa and the nasal sinuses have led Sluder to consider this fossa as an additional accessory sinus of the nose. Our recent knowledge of the effect of sinus disease upon neighboring structures such as the optic nerve must prepare us to understand that the spheno-palatine ganglion must frequently be involved in the same manner. In Sluder's experience, disease of the maxillary sinus has never involved the spheno-palatine ganglion though it frequently lies as close as 4 mm. from the posterior sinus wall. This is probably explained by the fact that the spheno-palatine artery and the descending palatine artery, together with their accompanying veins, and supporting connective tissue, lie between the ganglion and the posterior wall of the antrum.

The chief symptoms of involvement of Meckel's ganglion are neuralgic in character. The pain is felt at the root of the nose, around the orbital margin and occasionally in the eye, radiating into the upper jaw and teeth. In more severe cases the lower jaw may be involved and the pain extend to the ear. A point of especially severe pain is frequently noted about one inch behind the ear; from this point pain radiates to the back of the neck into the corresponding shoulder and arm. In unusual cases pain is felt in the throat and in the roof of the mouth.

Sluder has observed anesthesia of the velum palati which is usually higher on the affected side with the uvula deflected away from that side. The sense of taste is diminished on the affected side of the tongue. Conclusive proof of an affection of the spheno-palatine ganglion is obtained by cocainizing that area of the nasal wall near the ganglion. This relieves the symptoms and in early cases may check the neuralgic attacks.

Permanent relief may be obtained by injecting 5 per cent. carbolic acid in alcohol into the ganglion. A straight needle is used and the point entered beneath the posterior tip of the middle turbinal and forced through the thin bone into the upper portion of the pterygo-maxillary fossa. If the ganglion has been reached the typical pain symptoms will be temporarily intensified.

Sluder claims to have controlled the pain of glaucoma in ten cases by the application of cocain to the spheno-palatine foramen.

—(F. E. B.)

c. c. Abbreviation of *cubic centimeter.*

Cecità. (It.) Blindness.

Cecità dell'animo. (It.) Mental blindness.

Cecità di notte. (It.) Night-blindness. Hemeralopia.

Cecità per azzurro. (It.) Blue-blindness.

Cecità per i colori. (It.) Color-blindness.

Cecità per la neve. (It.) Snow-blindness.

Cécité. (F.) Blindness; cecity.

Cécité de neige. (F.) Snow-blindness.

Cécité des couleurs. (F.) Color-blindness.

Cécité des mots. (F.) Word-blindness.

Cécité psychique. (F.) Mental blindness.

Cécité verbale. (F.) Word-blindness.

Cecity. Blindness.

Cecograph. Chiragon. A writing machine for the blind.

Cecutiency. Tendency to, or commencement of, blindness.

Cedar. Cedrus libanotica. The oil of cedar was employed by the ancients as an ocular anesthetic, and the resin of the same tree was used for corneal opacities and to prevent the return of eyelashes after epilation.—(T. H. S.)

Cedmatophthalmia. (L.) Ophthalmia due to rheumatism or gout.

Celandine. Chelidonium glaucium et majus. Called by Scribonius Largus, "Glaucium," and by Pliny, both "Chelidonia" and "Ceratitis." Celandine was greatly esteemed by the ancients both in human and in veterinary ophthalmology. Numerous ointments were entitled "chelidonian," because one of their constituents was chelidonia.

The name chelidonia arose from an old Greek legend, according to which, when a young swallow suffers an injury to an eye, its mother brings to it a leaf of this plant, and, touching therewith the injured organ, effects an immediate cure.—(T. H. S.)

Cell-enclosure. Confinement within the cell proper; generally said of intracellular growths.

Cell-inclusion. The restriction of development and growth of micro-organisms to the cell proper—or to the intracapsular spaces within the cell-wall.

A good example of this condition arises in connection with trachoma.

As the result of numerous examinations of scrapings from the conjunctival epithelium in various conditions when stained by Giemsa's method, Lasarev and Petroff (*Ophthal. Review,* Sept., 1913, p. 278), are inclined to doubt the specificity of the *cell inclusions for trachoma,* and even to doubt that they have any pathogenic properties. They found the inclusions in 65 per cent. of cases of recent and untreated trachoma (266 cases), but also in 68 per cent. of non-trachomatous chronic conjunctivitis (46 cases). They also observed them in 53 per cent. of cicatricial trachoma (30 cases). In ophthalmia neonatorum the inclusions were found at the same time as the gonococcus, in some cases in one eye of the same patient gonococci and inclusions were present while in the other eye only inclusions were to be seen.

Cell-nests. These are collections of cells commonly found in epithelial exudates, noticed especially in epithelioma of the eyelids and in other situations.

Celloidin imbedding. Ophthalmic specimens that have been hardened and cut must be imbedded in some solid material in order to render sectioning with the microtome possible. Celloidin imbedding, proposed by Schieferdecker, was first applied for imbedding eyes by Becker, and is practically the best method. Celloidin (Schering) is obtained in sealed bottles. Thick celloidin is made by allowing a sufficient amount of celloidin to dissolve in equal parts of absolute alcohol and ether to make a fluid the consistency of thick syrup. Thin celloidin is obtained by further diluting thick celloidin with equal parts of absolute alcohol and ether until it is a thinner, less viscid fluid resembling collodion. After the globe has been hardened and dehydrated in absolute alcohol it is placed in an absolute alcohol and ether mixture, equal parts, for twenty-four hours. It is then put in thin celloidin for from four days to two weeks. The longer the specimen remains in the thin celloidin, the more thoroughly its tissues will be permeated by it. It is finally transferred to the thick celloidin and left in it for the same length of time, when all is ready for mounting.—(W. E. Fischer.)

Cells, Collecting. A term applied to certain cells in the retina. According to Hill (*System of Diseases of the Eye,* Vol. I, p. 386), "After the posterior roots have undergone arborization in the central gray matter of the spinal cord, multipolar cells collect the impulses which the roots have delivered and transmit them by their axis-cylinder processes to higher regions of the cord or brain. Such collecting cells, also, are to be found in the retina, and there is no analogy in other nerves from which we can judge as to the nerve-tissue in which we ought to expect that the axis-cylinder processes of these collecting cells will end."

Cells, Corneal. The corneal cells are of two kinds—fixed and wandering. The fixed corneal cells lie in the spaces of the stroma and for this reason are flat elements placed parallel to the surface. The cell-body consists of a delicate membrane, which only increases to a notable thickness in the neighborhood of the nucleus. On surface-section the cell-body is not visible after ordinary staining and only Held's stain shows it to be an extremely weak staining, finely granular or reticular structure of irregular form with a few broad processes. One gets a similar picture in gold preparations, as drawn by Druault and Fuchs.

The cells build a closed network, or better a trabeculum or syncytium, by the help of these processes. The nuclei of the corneal cells are markedly flattened, their thickness reaching only 2 mu or less. Therefore, in cross-section or when on edge, they seem to be very narrow, elongated, and dense staining; on surface view, on the other hand, they stain very weakly and are of a great variety of form, with rounded angles, lobulated, constricted like a kidney, or elongated

In general, they are larger than the nuclei of the sclera; rounded forms have a diameter of some 12 mu; elongated forms may attain a length of 27 mu. The nucleus has a very delicate and fine-meshed chromatin net and 1 to 3 very fine nucleoli lying in a district poor in chromatin. According to Ballowitz, each cell contains a microcentrum in the neighborhood of the nucleus in the form of two central bodies united by a bridge; yet no radiating arrangement of the protoplasm can be made out about this microcentrum. According to the view of v. Recklinghausen, the cells and their processes lie in an extensively subdivided system of canals and canaliculi (lymph canal system), which provides for the circulation of the fluid and the nutrition of the cornea. Since then it has been conclusively shown by Leber that this view is untenable. The union between the cells and the substantia propria is only more easily broken up than is the union between the respective lamellæ of the substantia propria, and for this reason one can inject the canal system about the cells, and for the same reason the wandering cells are principally found lying between the fixed cells and the substantia propria. The wandering cells are migratory leucocytes with clear or weakly granular protoplasmic bodies and heavy staining, lobulated or fragmented nuclei. Their form is determined by the amount of room which the cell has; in the clefts they are pressed down flat; within the lamellæ they appear to be drawn out into long spindles conforming to the direction of the fibres. Blood-vessels are entirely absent in the stroma of the cornea proper; on the other hand, a richly developed nerve-plexus is present; this is distributed over Bowman's membrane and to the epithelium, as well as to the stroma.—(Salzmann-Brown.)

Cells, Distributive. An expression intended to explain the origin of certain groups of cells in the lower animals and the developmental stages of the human nervous system. As Hill (*System of Diseases of the Eye,* Vol. I, p. 384) says, "The origin of sense-organs is to be traced to the fact that certain spots on the surface which, owing to their favorable situation or to chemical differentiations which gave rise to pigment, crystals, or other substances, were rendered particularly liable to stimulation, became the organs from which information of danger was most frequently transmitted to the muscle-fibres by whose contraction the danger was escaped. These sensitive spots were the first sense-organs. So long, however, as the sense-organs retained their connection with certain groups of muscle-fibres only, their usefulness must have remained extremely small. The next step in advance, and one which seems to have occurred with great rapidity, was the introduction of a distributive mechanism at the base of each sense-organ, by means of which it was placed in connection with various parts of the contractile sheet of mesoderm. There can be very little doubt that this commencement of a nervous system was affected by the deposition of certain of the cells of the primitive sense-organs, from their posts as scouts, and their utilization for the purpose of establishing communications between the cells which remained on the surface and the contractile cells. It is possible in the covered-eyed Medusidæ (the larger jelly-fishes) to find, only just beneath the surface, cells intermediate in form between sensory cells and ordinary nerve cells. The efficiency of these groups of distributive cells was soon increased by their union, by means of commissural fibres, into a central nervous system."

Cellule. (F.) Cell.

Cellulitis. (L.) Inflammation of areolar tissue.

Cellulitis of the orbit. Inflammation of the tissues in the orbit is generally due to the staphylococcus aureus or similar pus-producing micro-organisms. Pneumococci have been reported by Kuhnt, Weiss, Hirsch, and others; staphylococci by Pergens and Thompson; streptococci, and the influenza bacilli have, according to other observers, also produced this condition. See **Orbit, Cellulitis of the.**

Cellulitis, Orbital. See **Cellulitis of the orbit.**

Celluloid prothesis. Artificial eyes made of celluloid. An account of this form of prothesis is given in volume I, page 263 of this *Encyclopedia.*

Another use of celluloid devices is reported by Kaz (*Woch. f. Ther. u. Hyg. des Auges,* January 2, 1913), who describes a case of total ankylosymblepharon in which the introduction of celluloid film behind the lids acted very favorably, being followed by disappearance of granulations and enlargement of the cul-de-sac. The film was well borne by the eye. Subsequently he inserted a film prothesis, consisting of two layers of celluloid enclosing a piece of very fine silk upon which he had an iris sketched. The cosmetic result was a good one, as on account of the transparency of the film it was hard to tell that there was any scleral covering. Although subsequent suppuration necessitated removal of the prothesis, the case suggests three possible uses of the celluloid film: 1. As a corneal bandage in keratoectasia and staphyloma, as a substitute for Kuhnt's conjunctival flaps, and as a means of separating a trachomatous pannus from the upper lid. 2. As a protection against symblepharon, using for this purpose a plain film prothesis. 3. As a prothesis in total leucoma, instead of tattooage. See **Artificial eyes.**

Celluloid spectacles. At the twenty-seventh Meeting of the *Ophthalmogische Gesellschaft* in 1898 L. Weiss showed some celluloid spectacles made in the factory of Kirchner and Wilhelm of Stuttgart. They were fashioned out of thin, pressed celluloid and had perfectly transparent, plano-concave lenses which were very light but yet very firm. Small air-holes regulated changes of temperature.

The following varieties have been more or less used in practice:—*Single white shells,* intended for all cases of mild irritation of one eye, are indicated. Since the introduction of the treatment of open wounds we know that keeping up the function of an eye during the period of the healing of a wound from injury or operation has a certain value; and insofar as this, the monocular shells deserve to be preferred to spectacles in each and every instance. Above all, however, they have proven of value in cases of inflammation by foreign bodies or even after the disappearance of a foreign body which was not altogether superficially located, after which we are accustomed to apply spectacles (for the protection of the small wound of the cornea). In this case the one-sided white shells are in order, or if there is sensitiveness to light, the gray shells. They make treatment more easy for the physician and the condition more agreeable for the patient.

2. *The single gray shell* is used in case of the indications specified under 1 above, provided there is greater sensitiveness to light.

3. Of *the bilateral celluloid shells* especially the white ones have proved of value. Of the colored ones only the red-white and the green-red are considered. The former are used in examining for paralysis of the eye muscles, while the latter are used in examining persons suspected of malingering by means of the transparent red-green glass-board along with corresponding glasses.

The double-sided white celluloid glasses are the proper protections against injuries by foreign bodies. With their many superiorities to those which have been used hitherto they are liked at least as well as the others; but on the whole it must be admitted that their general introduction is hindered through the disinclination of people to work with guarded eyes, a fact which applies equally to the other spectacles.

In some occupations in which the workers are daily exposed to the dangers of injury by foreign bodies they seem to maintain their place although other kinds of spectacles are no longer used by these same workers.

4. *Bilateral gray spectacles* are as a matter of fact almost superfluous. As a common protective spectacle there is no question of their competing with the smoke gray shell spectacle; for obvious reasons they cannot displace the latter. On the other hand, they are in actual use on the high mountains where vanity no longer plays a role; at least in the case of the genuine mountain-climbers, for whom they are of

good service because they prevent the light from coming in at the side while they are of light weight as compared with the glasses used for protection hitherto, which were often quite heavy. *(Encyklopädie der Augenheilkunde.)*

Cellulosa choroideæ. The external layer of the choroid.

Celoscope. An instrument provided with an electric light for examining the cavities of the body. It is enclosed in a flask and mounted on a glass handle.

Celsus, Aulus Cornelius. (25 B. C.-50 A. D.) An ancient Roman encyclopedist, possibly a physician, and certainly the author of the oldest systematic treatise on ophthalmology extant from Greco-Roman times. There has been much discussion as to whether Celsus was or was not a physician. It is more than likely that he was a man of the leisure class who amused himself with studies of various kinds—among them the study of medicine—and that, at times, in a neighborly way, he did practice as a physician. There are signs in his work both of layman and of physician.

Among the numerous books by Celsus were works on agriculture, history, rhetoric, jurisprudence, the military art and medicine. Of all these compositions that on medicine only, "*De Medicina*," has come down to our day. The date of authorship of this extremely valuable book is very probably 29 or 30 A. D.; the book is, therefore, an exposition of the medical and surgical views of the civilized world at the beginning of the Christian era. The date of authorship is, indeed, as above given, that of the Crucifixion.

The work, *De Medicina,* is composed of eight books. The first treats of hygiene (for the most part, dietetics); the second, of general pathology and general therapy; the third, of general diseases; the fourth, of local diseases; the fifth, of materia medica; the sixth, of eye, ear, nose, mouth, throat, and genito-urinary diseases; the seventh, of surgery; while the eighth, or last, book is devoted to diseases of the bones. The ophthalmologic portions of the work consist of chap. vi, of Book six, and chap. vii of Book seven; and, inasmuch as these portions are not of excessive length, and inasmuch, further, as they constitute the earliest systematic treatise on our specialty which has come down to our day from Greco-Roman times, I take the liberty of subjoining in full an English translation thereof.*

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* For the most part, I have followed the excellent translation of Greive. Now and then, however, I have substituted for the words of Greive, those of Collier, or of Alexander Lee, and, in one or two instances, my own translation.

BOOK VI, CHAPTER VI.

OF THE DISORDERS OF THE EYES.

The foregoing affections are of minor importance. But our eyes are exposed to grievous and various maladies. And, since they contribute so large a share, both to the conveniences and the pleasures of life, they deserve our utmost care to preserve them.

Soon after the appearance of a lippitude, there are certain indications from which we may form a prognosis. For, if a discharge of ears, and a tumor, and a thick gum * have commenced at once; if that gum is mixed with tears, and the tears are not hot, also if the gum is white and soft, and the tumor not hard, there is no danger of the disorder continuing long. But if the tears are copious and hot, the gum little in quantity, the tumor small, and these are confined to one eye; the case will prove tedious, but without danger. And this species of lippitude is not at all painful; but is hardly ever removed before the twentieth day; sometimes it continues for two months, and sometimes not so long.

If the gum begins to be white and soft, and is mixed with tears, or both these have attacked two eyes at once; the lippitude may be of shorter continuance, but there is danger of ulcers. A dry and parched gum occasions pain, but terminates sooner; unless it have produced an ulcer.

A large tumor, if it be without pain, and dry, is void of all danger; if it be dry, but attended with pain, it commonly ulcerates; and, sometimes, from this case it happens that the eyelid is agglutinated [grows fast] to the eye. There is room also to fear an ulceration in the eyelids or the pupil, when, besides great pain, there is a discharge of salt and hot tears; or even when, after the tumor is removed, the tears flow for a long time mixed with the gum.

It is worse still, where the gum is pale or livid, the tears are scalding, or in great quantity, the head hot, and the pain reaches from the temples to the eyes, also if the person is distressed with wakefulness in the night; for in such circumstances generally the eye bursts, when it were to be wished that it would only ulcerate. A slight fever is of service to an eye that bursts inwardly. If it breaks and is protruded externally, the case admits of no remedy. If, from a black color, some part of it has become whitish, it continues long. But if it be rough and thick, even after the cure, it leaves some mark.

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* "*Pituita*," which Celsus believed to consist of inspissated tears, for the Meibomian glands were wholly unknown to him. These glands were known (barely) to Galen, who flourished somewhat more than a century later, and, in 1666, they were so thoroughly and correctly described by Heinrich Meibom, or Meibomius (De Vasis Plp. Novis Epist., Helmst.) that they have borne the name "Meibomian" ever since.

Hippocrates, the most ancient author we have, has observed in his writings, that the eyes are cured by bleeding, by medicines, the bath, fomentations, and drinking of wine. But he has not explained the proper times for these, and the reasons for their use; in which the principal part of medicine consists. There is also much benefit received from abstinence and clysters.

Eyes are sometimes seized with an inflammation, in which they are at once painted and swelled; and there follows a discharge of gum; sometimes more, sometimes less plentiful, or acrid. In such a case, the principal remedies are rest and abstinence. Wherefore, for the first day, the patient ought to lie in a dark place and even refrain from speaking; to take no food at all; if he can command himself, not so much as water; if he cannot do that, at least as little of it as possible.

But if the pains are severe, blood must be taken away, preferably on the second day; but if the case be urgent, on the first; especially if the veins in the forehead swell, the patient be strong, and there is a redundancy of matter; but if the illness be less severe, it calls for a milder cure. It is not necessary to give a clyster till the second or third day. But a small inflammation requires neither of these remedies; it is sufficient to rest and fast.

Nevertheless, long fasting is not proper in lippitudes, lest it render the gum more fetid and acrid; but, on the second day, some of the gentlest of those things that generate a thicker phlegm ought to be given, such as sorbile eggs; if the disorder be but slight, pulticula, or bread sopped in milk. On the following days, as much as the inflammation decreases, so much may the quantity of food be increased; but of the same kind; so that above all nothing salt, or acrid, or extenuating, be taken; and nothing be used for drink but water. And, with respect to diet, such a regimen is highly necessary.

Now, on the first day of the distemper, it is proper to mix p. X * i. of saffron, and p. X. ii. of the finest, whitest flour, with the white of an egg, to the consistence of honey; and to spread this upon a piece of linen, and apply it to the forehead, that by compressing the veins it may restrain the violent flux of gum. If saffron cannot be had, frankincense has the same effect. It makes no difference whether it be spread upon a bit of linen or wool. The eyes ought to be anointed with the following composition: as much saffron as can be held with three fingers, myrrh the size of a bean, of poppy tears the size of a lentil, are rubbed down together with passum, and daubed over the eyes with a probe. Another for the same purpose consists of myrrh

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* "p." stands for "pondo," meaning, simply, "weight." "X" is the sign of the "denarius," which was equivalent to 62 modern grains.

p. X. i. mandrake juice p. X. ii. poppy tears p. X. ii. rose-leaves, hemlock seed, each p. X. iii. acacia p. X. iv. gum p. X. viii. And these are applied in the day-time; but in the night, for promoting rest, it is not improper to lay on the crumb of white bread mixed up with wine. For that both restrains the flux of gum, and if any tears are discharged, it absorbs them, and does not suffer the eyes to be glued up.

If the pain of the eyes be so great as to make this application uneasy and too hard, both the white and the yolk of an egg must be dropped into a cup, and a little mulse added to them, and these mixed with the finger; when they are incorporated, soft wool combed ought to be dipped in it, and saturated with it, and applied over the eyes. This is light, and, by cooling, restrains the gums; besides, does not grow dry, nor suffer the eye to be glued. Barley meal also boiled and mixed with a boiled quince is a proper application. And it is no absurd practice to use rather a penecillum squeezed out of water, if the disorder be less severe, if more so, out of vinegar and water. The former applications are to be bound on with a roller, lest they fall off in the time of sleep; but it is sufficient to lay the penecillum on the eyes; both because it can be conveniently replaced by the patient himself, and because, when it has grown dry, it must be moistened again. If the disorder is so great as to prevent sleep for a long time, some of the medicines are to be given, which the Greeks call anodyne; and for a boy the size of a vetch is a sufficient dose; for a man the size of a bean. On the first day it is not fit to inject any thing into the eye, unless the inflammation be very great; for the gum is often rather invited than diminished by that means. But, on the second day, even in a severe lippitude, it is proper to relieve by the injection of medicines, when either the patient has been bled, or a clyster has been given; or it appears that neither of these was necessary.

There are many collyriums proper for this purpose invented by different authors; and new ones may still be made; since lenient and gently repelling medicines may be easily mixed in various proportions. I shall mention the most celebrated of them.

Philon's collyrium.—The collyrium of Philon contains of washed ceruss, spodium, gum, each p. X. i. poppy tears toasted p. X. i. It is fit to know, that all the ingredients must first be powdered separately, after that mixed and beaten up again, dropping in from time to time either water or some other liquid. Gum, as it possesses some other qualities, so has this peculiar effect upon collyriums, that when they have been long made, and are grown dry, they continue firmly united, and are not friable.

Dionysius'.—Dionysius' collyrium; of poppy tears toasted till tender p. X. i. toasted frankincense, gum, each p. X. ii. spodium p. X. iv.

Cleon's.—Cleon's is a very famous one; of poppy tears toasted p. X. i. saffron p. X. i. gum p. X. v. to these, while they are powdered, is added juice of roses. Another, by the same, stronger; of iron scales, which is called stomoma, p. X. i. saffron p. X. ii. spodium p. X. iv. lead, both washed and calcined p. X. i. and the same quantity of gum. There is still another of the same author's, chiefly useful where there is a great flux of gum; of castor p. X. i. aloes p. X. i. myrrh p. X. ii. prepared cadmia p. X. viii. a like quantity of antimony, juice of acacia p. X. xii. the mixture may be kept in a small box. But Theodotus added to this composition toasted poppy tears p. X. i. copper calcined and washed p. X. ii. date kernels toasted p. X. x. gum p. X. xii.

The acharistum of Theodotus.—But Theodotus' own, which by some is called acharistum, is thus made; of castor, Indian nard, each p. X. i. lycium p. X. i. poppy tears the same quantity; myrrh p. X. ii. saffron, washed ceruss, aloes, each p. X. iii. cadmia botryitis washed, calcined copper, each p. X. viii. gum p. X. xviii. juice of acacia p. X. xx. antimony the same quantity; to these is added rain water.

The cythion, or tephrion.—Besides these, amongst the most common collyriums is that, which some call cythion, others, from its ash colour, tephrion. It contains of starch, tragacanth, acacia juice, gum, each p. X. i. poppy tears p. X. ii. washed ceruss p. X. iv. washed litharge p. X. viii. these, in the same manner, are beaten up with rain water.

The trygodes of Euelpides.—Euelpides, who was the greatest oculist in our age, made use of one, which he had composed himself, and called it trygodes. It contains of castor p. X. ii. lycium, nard, poppy tears, each p. X. i. saffron, myrrh, aloes, each p. X. iv. calcined copper p. X. viii. cadmia and antimony, each p. X. xii. acacia juice p. X. xxvi. gum the same quantity.

The more violent any inflammation is, so much the more it requires to be alleviated by medicines, with the addition either of the white of an egg, or breast milk. But if neither a physician nor a medicine can be got, it mitigates the disorder to infuse either of these into the eyes by a penecillum made for the purpose. But when relief is obtained, and the flux of gum stops, the slight relics of the disorder, that might perhaps otherwise continue, are discussed by bathing and drinking wine. Therefore, the patient ought to bathe moderately, being first rubbed over with old oil, and longer in his legs and thighs than the rest of his body, and to foment his eyes with plenty of warm water; next to have warm water first, and afterwards water with the cold just taken off, poured over his head; after bathing, he must guard against being exposed to cold or wind. After this, his diet ought to be somewhat fuller than formerly; but he should abstain from all extenuants of phlegm; the wine he drinks should be mild, inclining to rough, of a moderate age; and in this he ought neither to indulge to excess, nor to be too sparing, that the former extreme may not occasion crudity, but that by a just quantity sleep may be procured, and the acrimony lurking within may be sheathed. But if a person in the bath has felt more uneasiness in his eyes than he did before (which usually happens to those who have made too much haste to get into it, while the flux of gum still continued), he ought to come out immediately; to drink no wine that day; and eat even less than he did the day before. Afterwards, as soon as the discharge of gum is sufficiently stopped, he must return again to the use of the bath.

Nevertheless, it sometimes happens, from some unfavorable circumstance either in the weather, or habit of the patient, that, for several days, neither the pain nor the inflammation, and, least of all, the discharge of gum ceases. When this is the case, and time itself has brought the disorder to a full maturity for it, relief is to be sought from the same remedies, that is, the bath and wine. For, though they are hurtful, while these complaints are recent, because they may irritate and inflame them; yet in the inveterate, which have not yielded to any other remedies, they are commonly very efficacious. For in this, as well as in other cases, when seemingly proper medicines have been tried in vain, those of a contrary nature give relief. But it is expedient for the patient, in the first place, to have his hair clipped close to the skin; next to foment his head and eyes in the bath very plentifully with warm water; then to wipe both with a penecillum, and anoint his head with ointment of iris; to lie in bed till all the heat acquired in the bath is gone off, and the sweat cease, which was necessarily collected in his head. Then he should make use of the same kind of food and wine above recommended, the latter undiluted; and cover his head, and continue to rest. For, after these, either a sound sleep, or a sweat, or a purging, often puts an end to the discharge of gum. If the disorder abates (which sometimes does not happen soon), the same course ought to be pursued for several days, till the cure be completed. If, on these days, he has no stool, a clyster must be injected for relieving the superior parts.

But sometimes a great inflammation arises, and of so violent a nature, that it propels the eyes from their cavity. The Greeks call this proptosis, because the eyes fall forward. It is plain such patients require bleeding, if their strength will admit of it; if that cannot be done, a clyster is necessary, and long fasting. The mildest medicines are required in this case. Therefore, some use the first of Cleon's two colyriums mentioned above. But that of Nileus is the best, and all authors agree to give it the preference to any other.

Nileus' collyrium.—It is this: Indian nard, poppy tears, of each p. X. i. gum p. X. i. saffron p. X. ii. fresh rose-leaves p. X. iv. which are brought to a consistence either by rain water, or light wines inclining to rough. And it is not improper to boil pomegranate bark or mellilot in wines, then to bruise it; or to mix black myrrh with rose-leaves; or henbane-leaves boiled with the white of an egg; or meal with acacia juice, or passam, or mulse. And if poppy leaves too be added, they will be somewhat more efficacious. When some one of these is prepared, the eyes ought to be fomented`with a penecillum squeezed out of a warm decoction of myrtle or rose-leaves in water; after that the medicine is to be applied. Besides, the skin in the back of the head is to be cut, and a cupping vessel applied to it.

If, by these means, the eye is not restored to its place, but continues prominent as before, we may conclude the eye sight is gone; and that the eye will next grow hard, or be converted into pus. If the suppuration appears in that angle which is next the temple, an incision must be made in the eye, that vent being given to the matter, the inflammation and pain may cease, and the coats of the eye fall inward, so that the face may be less disfigured afterwards. And then must be used either the same collyriums with milk, or an egg, or else saffron mixed with the white of an egg. But if it has grown hard, and is mortified without turning to pus, so much of it must be scooped out, as to prevent a shocking projection; which must be done thus. The external coat must be laid hold of with a hook, and below that the incision made with a knife; then these medicines are to be injected, till the pain be entirely gone. The same medicines are also necessary for an eye, that is first protruded, and afterwards bursts in several places.

Of carbuncles of the eyes.—It is not uncommon for carbuncles to proceed from an inflammation, sometimes in the eyes themselves, sometimes in their lids; and in the last they are sometimes in the inside, at other times on the outside. In this case, a clyster must be given; the quantity of food lessened; milk allowed for drink; that the offending acrimony may be sheathed. As to cataplasms and medicines, we must use such as have been proposed against inflammations. And here also the collyrium of Nileus is the best. But if the carbuncle be on the external part of the eye-lid, linseed boiled in mulse is the most proper for a cataplasm; or if that is not to be had, wheat meal boiled in the same manner.

Of pustules of the eyes.—Sometimes pustules also proceed from inflammations. If this happens in the beginning of the inflammation, the former directions about bleeding and rest are even to be more punctually observed; if later than to admit of bleeding, yet a clyster must be given. If, for any reasons, that likewise is impracticable, at least the proper diet must be used. In this case too, the mild medicines are necessary; such as that of Nileus or Cleon.

Collyrium of Philes.—The collyrium which takes its name from Philes, is also suited to this disorder. For it contains of myrrh, poppy tears, each p. X. i. washed lead, Samian earth, which is called aster, tragacanth, each p. X. iv. burnt antimony,* starch, each p. X. vi. washed spodium, washed ceruss, each p. X. viii. which are incorporated with rain water. This collyrium is used mixed either with an egg, or milk.

From pustules sometimes are generated ulcers; and these, when recent, are to be dressed with the like lenient medicines, and mostly the same as I have prescribed above for pustules. There is also a particular application for them, which is called dialibanou. It contains of copper calcined and washed, poppy tears toasted, each p. X. i. spodium washed, frankincense, antimony calcined and washed, myrrh, and gum, each p. X. ii.

Wasting of the eyes.—It happens, likewise, that the eyes, either one or both, become less than they ought to be naturally. And this is caused by an acrid flux of gum in a lippitude, also by continual weeping, and wounds badly cured. In such cases, the same mild medicines with breast milk are to be used; and such food as most nourishes and fills the body; and the patient must carefully avoid whatever occasions weeping, and all the anxiety of domestic affairs; and if any misfortune happens likely to disturb him, it must be concealed from his knowledge; acrid medicines and acrid food hurt by occasioning tears, as much as any other way.

Lice in the eye-lids.—There is a peculiar kind of disorder, in which lice are generated amongst the hair of the eye-lids. This the Greeks call phthiriasis. Which arising from a bad habit of body, seldom stops there; but generally after some time there follows a smart flux of gum; and the eyes themselves being greatly ulcerated, it even destroys the sight.

Such patients must be purged by clysters; the hair of their head clipped close to the skin, and the head rubbed for a long time every day fasting. They must diligently practise walking, and other exercises; gargle with a decoction of catmint and a mellow fig in mulse; foment the head often in the bath with plenty of warm water; avoid acrid food; use good milk and wine, and also drink more freely than they eat. Medicines too are to be given internally, of a mild nature, that they may not generate any acrid gum; and others externally applied to kill the lice, and prevent the production of more. For this purpose, of aphronitre p. X. i. sandarach, p. X. i. stavesacre p. X. i. are powdered together, and then equal quantities of old oil and vinegar are added, till the whole come to the consistence of honey.

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* "The antimony is rubbed over the suet, and hid in the fire till the suet is burnt, and then being taken out, it is extinguished in the milk of a woman, that has a male child, or in old wine." *Dioscorid.* lib. v. cap. 873.

Collyrium of Andreas.—Thus much of those distempers of the eyes, which are cured by mild medicines. There are besides these, other kinds, which require a different treatment, commonly proceeding from inflammations, but continuing even after they are gone. And in the first place, a flux of thin gum continues in some. To such patients, clysters should be given, and their quantity of food diminished. Neither is it improper to anoint the forehead with the composition of Andreas: which consists of gum p. X. i. ceruss, antimony, each p. X. ii. litharge boiled and washed p. X. iv.; the litharge is boiled in rain water; and the dry medicines are rubbed with the juice of myrtle. These being spread upon the forehead, a cataplasm of meal is also to be applied over it, made into a paste with cold water, and with the addition either of acacia juice or cypress. It is proper also to make an incision on the top of the head, and apply a cupping vessel there; or to bleed at the temples. The eye ought to be anointed with that composition, which contains of copper scales, poppy tears, each p. X. i. hartshorn calcined and washed, washed lead, gum, each p. X. iv. frankincense p. X. xii. Now, this collyrium, because horn is one of the ingredients, is called diaceratos. As often as I do not subjoin what kind of moisture is to be added, I would be understood to intend water.

The memigmenon of Euelpides.—For the same purpose is that of Euelpides, which he called memigmenon. In it there are poppy tears and white pepper, of each an ounce, gum a pound, calcined copper p. X. i. During this course, with some intervals, the bath and wine are serviceable. And as extenuating food must be avoided by all that labor under a lippitude; so particularly by those, that have for a long time a flux of thin humor. But if they be surfeited with such food as generates a thicker phlegm, as is most common in this kind of diet, they must have recourse to that, which, because it binds the belly, constringes the body too.

But ulcers, that do not go off with the inflammation, generally either grow fungous, or foul, or at least inveterate. Their excrescences are best suppressed by the collyrium called memigmenon. The foul ones are deterged both by the same, and by that which is called smilion.

Smilion.—This contains of verdigris p. X. vi. gum the same quantity, ammoniacum, minium from Sinope, each p. X. xvi. these are rubbed down by some with water, by others, to make them stronger, with vinegar.

Phynon of Euelpides.—That of Euelpides, which he called phynon, is also suitable to this case; of saffron p. X. i. poppy tears, gum, each p. X. ii. copper calcined and washed, myrrh, each p. X. iv. white pepper p. X. vi. But the application of this must be preceded by an ointment.

Sphærion of the same author.—The collyrium of the same author, to which he gave the name of sphærion, is of like virtue; of bloodstone washed p. X. ii. pepper six grains, cadmia washed, myrrh, poppy tears, each p. X. iii. saffron p. X. iv. gum p. X. viii. which are rubbed down with Aminaean wine.

A liquid medicine by the same.—He likewise compounded a liquid medicine for the same purpose, in which were the following things: of verdigris p. X. i. minium calcined, copperas, cinnamon, each p. X. iii. saffron, nard, poppy tears, each p. X. i. myrrh p. X. ii. calcined copper p. X. iii. aromatic ashes p. X. iv. pepper 15 grains. These are rubbed with a rough wine, and then boiled with three heminæ of passam, till the whole unites. And this medicine becomes more efficacious by keeping.

For filling the cavities of ulcers of the eyes, the best of all those we have mentioned are the sphærion and the collyrium of Philes. The same sphærion is an excellent medicine for inveterate ulcers, and such as can scarcely be brought to cicatrize.

Hermon's.—There is also a collyrium, which though it be serviceable in many cases, yet seems to be most efficacious in these ulcers. It is said to be invented by Hermon. It contains of long pepper p. X. i. Z. white pepper p. X. i. cinnamon, costus, each p. X. i. copperas, nard, cassia, castor, each p. X. ii. galls p. X. v. myrrh, saffron, frankincense, lycium, ceruss, each p. X. viii. poppy tears p. X. xii. aloes, calcined copper, cadmia, each p. X. xvi. acacia, antimony, gum, each p. X. xxv.

Asclepias.—Cicatrices formed from ulcers are liable to two defects: of being either concave, or protuberant. If they be concave, they may be filled by the sphærion collyrium; or that which is called asclepias. This consists of poppy tears p. X. ii. sagapenum, opopanax, each p. X. iii. verdigris p. X. iv. gum p. X. viii. pepper p. X. xii. cadmia washed, ceruss, each p. X. xvi.

Canopite.—But if the cicatrices are thick, they are rendered thin by the smilion, or canopite collyrium, which last contains cinnamon, acacia, of each p. X. i. cadmia washed, saffron, myrrh, poppy tears, gum, each p. X. ii. white pepper, frankincense, each p. X. iii. calcined copper, p. X. ix. with rain water.

Pyxinum of Euelpides.—Or the pyxinum of Euelpides, which consists of the following ingredients: of fossil salt p. X. iv. ammoniacum thymiama p. X. viii. poppy tears p. X. xii. ceruss p. X. xv. white pepper, Cilician saffron, each p. X. iii. gum p. X. xiii. cadmia washed p. X. ix. Yet the composition, which contains gum p. X. iii. verdigris p. X. i. crocomagma p. X. iv. seems to be the best for removing a cicatrix.

There is also another kind of inflammation, in which, if the patient's eyes swell, and are distended with pain, it is necessary to bleed in the forehead; and to foment the head and eyes plentifully with hot water; to gargle with lentils, or cream of figs; to anoint with the acrid medicines mentioned above; particularly that which is called sphærion, and which has blood-stone in it. And others are useful too, which are calculated to lessen the roughness; of which I am going to speak.

This commonly follows an inflammation of the eyes; sometimes it is more violent, at other times more slight. Sometimes too, a roughness occasions a lippitude, and that again increases the roughness, and in some it is short, in others it continues a long time, and so as to be hardly ever cured.

In this kind of disorder some scrape the thick and hard eye-lids both with a fig-leaf and a specillum asperatum, and sometimes with a knife; and turning them up, they rub them every day with medicines. Which ought not to be practised, unless in a considerable and inveterate roughness, nor that often. For the same end is better obtained by a suitable regimen and proper medicines. Therefore we shall use exercises and the bath more frequently; and foment the eyelids with plenty of warm water. The food must be acrid and extenuating.

Cæsarian.—The medicine, which is called Cæsarian, contains of copperas p. X. i. misy p. X. i. white pepper p. X. v. poppy tears, gum, each p. X. ii. cadmia washed p. X. iii. antimony p. X. vi. And this collyrium is allowed to be a good remedy against every kind of disorder in the eyes, except those that are treated by mild medicines.

Hierax's.—That also, which is called Hierax's, is powerful against a roughness. It consists of myrrh p. X. i. ammoniacum thymiama p. X. ii. rasile verdigris p. X. iv. with rain water. For the same purpose that also is proper, which is called canopite, and the smilion, and the pyxinum, and the sphærion. But if compound medicines are not at hand, a roughness may be easily enough cured by goat's gall or the best honey.

Dry lippitude.—There is likewise a kind of dry lippitude, which the Greeks call xerophthalmia. In this the eyes neither swell nor run, but are only red, and heavy with some pain, which is commonly slight, also an itching, and the eye-lids without any hardness stick together in the night-time by means of a very troublesome gum; and the less violent in its degree this species is, so much the longer does it continue.

In this disorder it is necessary to walk much, to take much exercise, to bathe often, and to sweat in the bagnio, to use much friction. The proper diet is neither such as is filling nor over acrid, but the middle kind between these. In the morning, when it is evident that the concoction is completed, it is not improper to gargle with mustard, and after that to rub the head and face a considerable time.

Rhinion.—The collyrium best adapted to this case is that called rhinion. Which contains of myrrh p. X. i. poppy tears, acacia juice, pepper, gum, each p. X. i. blood-stone, Phrygian-stone, lycium, seissile-stone, each p. X. ii. calcined copper p. X. iv. The pyxinum also is suitable for the same purpose.

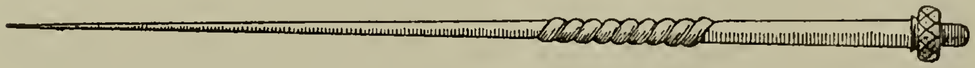
Basilicon of Euelpides.—But if the eyes be scabrous, which mostly happens in the angles, the rhinion mentioned already may be serviceable. For the same purpose that may be useful, which contains, of rasile verdigris, long pepper, poppy tears, each p. X. ii. white pepper, gum, each p. X. iv. cadmia washed, ceruss, each p. X. vi. However, there is none better than that of Euelpides, which he called basilicon. It contains of poppy tears, ceruss, Asian-stone, each p. X. ii. gum p. X. xiii. white pepper p. X. iv. saffron p. X. vi. psoricum p. X. xiii. Now there is no simple, which by itself is called psoricum; but a certain quantity of chalcitis and a little more than half its quantity of cadmia are rubbed together with vinegar; and this being put into an earthen vessel, and covered with fig-leaves, is deposited under ground for twenty days, and being taken up again it is powdered, and thus is called psoricum. The basilicon collyrium, too, is generally allowed to be proper for all disorders of the eyes, that are not treated by mild medicines.

But when compound medicines are not to be had, both honey and wine mitigate an asperity in the angles. These and a dry lippitude too are relieved by an application of bread, softened with wine, over the eyes. For since there is generally a humor, which exasperates sometimes the eye itself, sometimes the angles, or eyelids; by this application, if any humor is discharged, it is drawn away, and if it happens to be lodged near, is repelled.

Of a dimness in the eyes.—A dimness comes upon the eyes, sometimes from a lippitude, at other times even without that, from old age, or weakness. If the disorder proceeds from the relics of a lippitude, the collyrium called asclepias is serviceable. Likewise that which is composed of crocomagma.

The collyrium, which is called diacrocou is composed peculiarly for this. It contains of pepper p. X. i. Cilician saffron, poppy tears, ceruss, each p. X. ii. psoricum, gum, each p. X. iv.

But if it arises from old age or weakness, it may be proper to anoint with the best honey, and cyprine and old oil. But it is most expedient to mix together one part of balsam, and two of old, or cyprine oil, and three parts of the most pungent honey. The medicines prescribed above for a dimness from a lippitude, and those mentioned before for diminishing cicatrices, are useful in this case too.



Cataract Needle of Celsus.

Whoever is troubled with a dimness must walk much, use exercise, frequent bathing, at which time the whole body must be rubbed, but principally the head, with iris ointment till it sweats; after that it must be veiled, and not uncovered, till after he has got home, and the sweat and heat have ceased. Then he must keep to an acrid and extenuating diet; and after the interval of some days use a gargarism of mustard.

Of a cataract.—A suffusion also, which the Greeks call hypochysis,* sometimes obstructs the pupil of the eye, where vision is performed.

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* The term ''cataract'' was invented by Constantinus Africanus (A. D. 1018-1085) who first employed the expression (''cataracta'') in the title of the 27th chapter of his little book, ''*De Oculis,*'' which was largely a compilation from the Arabians. The Arabic term was either ''ma'' (= water) or ''al-ma an-nazil fil ain'' (= the water that runs down into the eye).

It ought to be added that the Greek ''hypochyma,'' or ''hypochysis,'' the Latin ''suffusio,'' the Arabic ''ma'' and the Mediæval Latin ''cataracta,'' were all employed to cover without distinction what today are known as hypopion, pupillary membrane, cataract, and even vitreous opacity. Indeed as late as the middle of the 12th century, the term ''cataracta'' was used for an opacity ''inter conjunctivam et corneam.''

The ancient operation for cataract, or *suffusio,* was, when successful (and sometimes when not) what today is known as a ''reclination.'' But the ancient operator had no thought at all that what he was doing was dislocating the crystalline lens. In fact he believed the lens to be the essential organ of vision, as we today think, or rather know, that the retina is. A dislocation of the lens would, to him, have meant absolutely nothing more or less than absolute blindness. What he thought he was doing when performing a cataract operation, was, tearing away from a (wholly imaginary) space between the pupil and the lens a mass of ''inspissated humor,'' which had ''flowed down'' (hence the later expression, ''catar-

If this disorder be inveterate, it requires an operation to remove it. At the beginning, sometimes it is discussed by certain methods adapted to the case. It is expedient to bleed in the forehead, or nose; to cauterize the veins in the temples; by the use of gargarisms to evacuate phlegm; to use fumigations: to anoint the eyes with acrid medicines. The best diet is such as extenuates phlegm.

A palsy of the eyes.—Nor is a palsy of the eyes (which the Greeks call paralysis) to be cured by any different diet, or different medicines, so that it is needless to do more than describe the distemper. It happens, then, sometimes in one eye, sometimes in both, either from a blow, or from an epilepsy, or spasms, where the eye itself is strongly convulsed, so that it can neither be directed to any particular object, nor be kept fixed; but moves to and fro involuntarily; and therefore cannot see anything distinctly.

Of a mydriasis.—What the Greeks call a mydriasis is not very different from this distemper. The pupil is dilated, the sight grows dull, and almost dim. This kind of weakness is extremely difficult to remove. Against both disorders, that is, the palsy and mydriasis, we must use the same remedies as have been prescribed in a dimness of the eyes, with a few alterations; thus, for the head, to the iris oil must be added sometimes vinegar, sometimes nitre; it is sufficient to anoint the eyes with honey. In the latter disorder some have made use of hot waters, and been relieved; others, without any apparent cause, have suddenly lost their sight. Some of these, after continuing blind for some time, from a sudden purging, have recovered their sight; whence it seems the less improper, both when the disorder is recent, and when it is of some standing, to procure stools by medicines, in order to force all the noxious matter into the lower parts.

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acta'') into that space, and, later, gone through some sort of process of thickening and drying. What he was really doing, however, was, now and then, to fumble ineffectually at a hypopion, again to tear, more or less ineffectually, at a pupillary membrane, or at a vitreous opacity, or, once more, to recline an actually opaque lens—in the last-named instance, of course, very often with good results.

In the middle ages, an Arab, Ammar (in the earlier portion of the 11th century) invented the suction operation, and, after that, there were practiced the two procedures—reclination and suction. But the pathological conception of a ''suffusion,'' or ''cataract,'' remained the same.

A great French ophthalmologist, St. Yves, was the first in history (1707) to extract the lens; but it was only a lens which had been already dislocated into the anterior chamber. For St. Yves's greater compatriot, Jacques Daviel, remained the incomparable honor of being the first to extract a cataract from its normal position behind the pupil. The first publication of this procedure was in 1748.

One ought to add, for the sake of perfect clearness, that ancient authors, and sometimes those of the middle ages, did sometimes speak of ''extracting'' a cataract. But what they meant, beyond all question, was not the extraction of an opaque lens from the eye as a whole, but only of an inspissated membrane from the space which they believed to exist between the lens and the pupil, and into a lower space.

A weakness of the eyes.—Besides these, there is a kind of weakness of the eyes, in which patients see well enough in the daytime, but not at all in the night; which never happens to a woman, when her menstrual discharge is regular. But persons laboring under this disorder, ought to be anointed with the blood of a liver (particularly the liver of a he goat; if that cannot be had, of a she goat) that drops from it while roasting; and they ought to eat the liver itself. They may, nevertheless, not improperly make use of the same medicines that extenuate either cicatrices or an asperity. Some powder the seed of purslane, and add honey to it, till the mixture be of such a consistence, as not to drop off a probe, and anoint with that. They must also use exercises, bathing, and frictions.

Of external hurts in the eyes.—These disorders all arise from internal causes. But externally the eye may be hurt by a blow, so as to become blood-shot. There is nothing more proper for this case than anointing with the blood of a pigeon, or ringdove, or swallow. Nor is this practice without reason; since the sight of these birds being hurt by some accident, in a little time is restored, and that of the swallow soonest; which gave rise to the fable, that their parents perform by an herb the cure, which is really the work of nature. Their blood, therefore, is a very proper remedy for our eyes in external hurts, in these different degrees of efficacy; the blood of a swallow is best, next that of a ringdove; that of a pigeon is least medicinal both to itself and us.

Over an eye that has received a blow, in order to assuage the inflammation, it is also proper to apply cataplasms. Now, sal ammoniac, or any other, ought to be very finely powdered, oil being dropped in by degrees, till it acquire the consistence of strigment. Then this is to be mixed with barley-meal boiled in mulse. Upon a review of all the cures published even by physicians, it is easy to see, that there is hardly one of the above-mentioned disorders of the eyes, which may not be sometimes removed by very simple and obvious remedies.

BOOK VII, CHAPTER VII.

OF THE DISEASES OF THE EYES, WHICH ARE CURED BY MANUAL OPERATIONS.

But as the foregoing disorders do not differ much either in their nature, or method of cure, so these in the eyes, which require manual operations, are both different in their kinds, and require different methods of cure.

Of vesicles in the upper eye-lids.—In the upper eye-lids, then, it is common for fat and heavy vesicles to rise, which scarcely allow the eye to be raised, and occasion gentle, but constant fluxes of gum in the eyes. And they commonly happen to children. In this case it is necessary to compress the eye with two fingers, and thus stretching the skin, to cut with the knife in a transverse line, with a very light hand, in such a manner as not to wound the vesicle, and so that it may pass out when a way is made for it; then to catch hold of it with the fingers, and pull it out; for it easily separates: After this, the part ought to be anointed over with any of those collyriums, that are used in lippitudes; by which means it is covered with a cicatrix in a very few days. It is more troublesome when the vesicle is cut; for it discharges its humor, and cannot be laid hold of after, because of its smallness. If that accident should happen, one of the medicines that promote a digestion, may be laid on.

Of a crithe.—In the eye-lid likewise, above the lashes, grows a small tubercle, which, from its resemblance to a barleycorn, is by the Greeks called crithe. It is contained in a coat, and seldom maturates. Upon this should be applied hot bread, or wax heated now and then, provided the degree of heat be no more than the part can easily bear; for by this method it is often discussed, sometimes maturated. If pus appear, it ought to be divided by a knife, and the contained humor squeezed out; and to be afterwards treated with the same warmth, and anointed, till it recover a sound state.

Of chalazia.—Other tubercles, not unlike this, grow in the eye-lids; but, however, not of the same form, and also movable, when they are impelled this way or that by the finger; which, because of their resemblance to hail-stones, the Greeks call chalazia. These ought to be cut on the external side, if they be immediately under the skin; on the internal, if they lie below the cartilage; after that, they must be separated by the handle of the knife from the sound parts. And if the wound be on the external side, it must be anointed at first with mild, and afterwards more acrid medicines; if on the external, an agglutinating plaster must be applied over it.

Of the unguis.—The unguis, called by the Greeks pterygium, is a small nervous membrane, which, arising from the angle of the eye, sometimes reaches to the pupil, and obstructs the sight. It oftener begins from the angle near the nose, sometimes too from that towards the temples. It is no difficult matter to discuss this, when recent, by the medicines which lessen cicatrices in the eyes. If it be of long standing, and has acquired some thickness, it ought to be cut out. After an abstinence of one day, the patient must be placed in a seat, either with his face opposite to the physician, or with his back to him, in such a manner, that he may recline his head upon his breast. Some, if the disease be in the left eye, choose to have him sit with his face to the physician; if in the right, in the reclined posture. One eye-lid ought to be opened by an assistant, and the other by the physician. If the physician face him, he must take hold of the lower one; if he be reclined, the upper one. Then the physician is to fix under the extremity of the unguis, a small sharp hook, with its point turned a little inward; and to let go the eye-lid, which is then to be held by an assistant, and taking hold of the hook, he is to lift up the unguis, and pass a needle through, drawing a thread after it: then to lay aside the needle, and take hold of the ends of the thread, and by them raising up the unguis, if it adheres anywhere to the eye, to separate it by the handle of the knife, till he come to the angle; then alternately sometimes to slacken, sometimes to draw it, that so both its origin and the extremity of the angle may be found. For there is a double danger attends it;. either lest some part of the unguis be left, which being ulcerated is hardly ever cured, or lest the caruncle be cut away from the angle; for if the unguis be drawn away with too much force, that also follows and comes away. If it is torn off, an orifice is opened, through which afterwards a humor always descends, which the Greeks call rhyas. The true termination then of the angle must be found out. When that plainly appears, the knife is to be used, the unguis not being too straight drawn; and then this small membrane is to be cut out in such a manner, that no part of the angle be wounded. Afterwards lint, covered with honey, must be laid on, and over that a linen cloth, and either sponge, or succid wool. The following days, the eye must be opened daily, lest the eye-lids be agglutinated together by a cicatrix (for that is also a third danger) and lint be put on in the same way; lastly, it must be anointed with a collyrium, that cicatrizes ulcers.

But this operation should be performed in the spring, or at least before winter. Which circumstance, though it belongs to several places, it will be sufficient to mention once for all. For there are two kinds of cures; one, in which we are not at liberty to choose a time, but that must be laid hold of, that offers, as in wounds and fistulas; another, in which we are not pressed for time; but it is quite safe and easy to wait the most convenient season; as is the case in those disorders, which both increase slowly, and are not extremely painful. In such we must defer it till spring; or if there is any urgent circumstance, the autumn however is better than the winter or summer; and of that the middle, when the excessive heats are gone, and the colds not yet set in. Now, the more necessary the part is, whose cure shall be undertaken, the greater will the danger be it is exposed to. And often by how much larger the wound is to be made, so much the more must the season of the year be regarded.

Of an encanthis.—From the operation for the unguis, as I observed, disorders arise, which may also sometimes proceed from other causes. For sometimes after the imperfect excision of an unguis, or upon some other occasion, a tubercle grows in the angle, which hinders the entire opening of the eye-lids; the Greek name for it is encanthis. It ought to be laid hold of with a hook, and cut round; and here also the operator must be cautious not to cut away anything from the angle itself. Then a small piece of lint must be sprinkled either with cadmia, or copperas; and the eye-lids being opened, it must be introduced into that angle, and bound over in the same manner as the former; and for some following days must be dressed in like manner, first bathing it with water, just warm, or even cold water.

Of the ancyloblepharon.—Sometimes the eye-lids grow together, and the eye cannot be opened. Which is often attended with this disorder besides, that the eye-lids adhere to the white of the eye; that is when an ulcer in either of them has been negligently cured. For as it heals, what might, and ought to have been separated, will be agglutinated; both species of the distemper are called by the Greeks ancyloblepharon. When the eye-lids only cohere, they are separated without difficulty: but sometimes to no purpose; for they are agglutinated again. However, trial ought to be made; because the case often turns out well. Therefore, the broad end of the probe must be introduced between them, and the eye-lids separated by that; then small penicilla are to be put between them, till the ulceration of the part be cured. But when the eye-lid adheres to the white of the eye itself, Heraclides the Tarentine advises to cut under it gently with a knife with great caution, lest anything be cut away either from the eye, or the eye-lid; and if that cannot be entirely avoided, rather to take something from the eye-lid. After these, let the eye be anointed with such medicines as cure an asperity; and the eye-lid be inverted every day, not only that the medicine may be applied to the ulcer, but also to prevent its adhesion; the patient himself must also be charged to raise it often with two fingers. I do not remember an instance of one person cured by this method. Meges, too, tells us he tried many ways, and never was successful; for the eye-lid always adhered again to the eye.

Of the ægilops.—Again, in that angle that is next the nose, from some disorder, a kind of small fistula [Our "lachrymal fistula."] is opened, through which gum [pus] perpetually distills; the Greeks call it ægilops. And this gives constant uneasiness to the eye; sometimes also eating through the bone, it penetrates to the nostrils. This sometimes is of a cancerous nature; when the veins are tense and crooked, the color of it is pale, the skin hard, and irritated by a slight touch, and it raises an inflammation in the contiguous parts. It is dangerous to attempt the cure of those that are cancerous; for it even hastens death. And it is needless to meddle with such as reach to the nostrils; for neither do they heal. But the cure of these in the angle may be attempted; though it should be known however that it is difficult; and the nearer to the angle the opening is, so much the more difficult, because there is very little room for the management of the hand. It is easier to cure the disorder when recent. The top of the opening must be taken hold of with a small hook; and then all the cavity, as I directed in fistulas, must be cut out to the bone; and the eye and other contiguous parts being well covered, the bone must be strongly cauterized with a hot iron. But if it be already affected with a caries, that a thicker scale may cast off, some apply caustic medicines; as copperas, or chalcitis, or rasile verdigris; which method is both slower, and not so effectual. When the bone is cauterized, the remaining part of the cure is the same as in other burns.

Of hairs in the eye-lashes irritating the eye.—The hairs of the eyelids sometimes irritate the eye; and that from two causes. For sometimes the skin of the eye-lid is relaxed, and falls down; whence it happens, that the lashes are turned in upon the eye itself, because the cartilage is not also relaxed; at other times, beside the natural row of hairs, another grows under it, which point directly inward upon the eye. The methods of cure are these. If preternatural hairs have grown, an iron needle, thin and broad, like a spatha,* must be put into the fire, and when it is red-hot, the eye-lid being lifted up in such a manner, that the offending lashes are in the view of the operator, it must be passed from the angle close to the roots of the hair, till it move over the third part of the eye-lid; then it must be applied a second and third time, as far as the other angle. The consequence of which is, that all the roots of the hairs being burnt, die away. Then a medicine to prevent an inflammation must be applied; and when the eschars have cast off, it must be brought to cicatrize. This kind heals very easily. Some allege that it is proper to pierce the external part of the eye-lid near the eye-lashes with a needle, which must be passed through with a woman's hair doubled for a thread; and when the needle has gone through, that the offending hair must be taken up into the loop of the woman's hair, and by that drawn upward to the superior part of the eyelid, and there to be glued down to the flesh, and a medicine applied to close up the orifice thus made; for that this will cause the eye-lash to point afterwards externally. This in the first place cannot be practised, but upon a pretty long hair; whereas they generally grow short there. And then, if there be several hairs, the patient must suffer a long torture, and the needle passing so often through, will raise a great inflammation. Lastly, when any humor is settled there, the eye being irritated both before by the hairs. and afterwards by the perforations of the eye-lids, it is hardly possible to prevent the glutinous matter, which fastens the hair, from being dissolved; and thus of course the hair returns to the place from whence it was drawn away.

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* A "spatha" was the ordinary sword of a Roman soldier. It was short, broad, thin, straight and flat, and had an acute point and sharp edges.

The method of cure for a relaxed eye-lid, which is universally practised, never fails of success. For the eye being closed, one must take hold of the middle part of the skin of the eye-lid, whether it be the upper or the lower, with his fingers, and raise it, then consider how much must be taken away, to reduce it to its natural condition. For there are two dangers attending this case; lest if too much be cut off, the eye cannot be covered; if too little, the end be not obtained, and the patient have suffered to no purpose. The part which it shall be thought needful to cut, must be marked by two lines with ink in such a manner, that between the range of hairs and the line nearest to it. some space may be left for the needle to lay hold of. These things being determined, the knife is to be used; and if it be the upper eye-lid, the incision next the eye-lashes must be made first; if the inferior one, last; and it must begin in the left eye, at the angle next the temple; in the right, at the angle next the nose; and what lies between the two lines must be cut out.* Then the lips of the wound are to be joined together by a single stitch, and the eye must be covered; and if the eye-lid does not descend far enough, it must be relaxed; if too much, it must be either straighter drawn, or a small habenula again cut off from that lip of the wound, which is farthest from the eye-lashes. When it is cut off, other stitches must be added, not above three. Moreover a scarification must be made in the upper eye-lid, under the roots of the eye-lashes, that being raised from the inferior part, they may point upwards; and this alone will be sufficient for the cure, if they are but little turned in. The lower eye-lid does not need this process. When these are done, a sponge squeezed out of cold water must be bound on; the day following an agglutinating plaster should be applied. On the fourth, the stitches must be taken away, and the wound anointed with a collyrium, to prevent an inflammation.

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* No such detailed instructions are found in any other writings on ocular surgery prior to the time of Celsus.

Of the lagophthalmus.—Sometimes from this operation, when too much of the skin is cut away, it happens, that the eye cannot be covered. And this sometimes proceeds from another cause. The Greeks call the disorder lagophthalmos (or hare's eye). When too much of the eye-lid is wanting, there is no remedy for it; if but a small part, it may be cured. An arched incision must be made in the skin, a little below the eye-brow, with its horns pointing downward. The wound ought to go as deep as the cartilage, but without injuring it; for if that be cut, the eye-lid falls down, and cannot afterwards be raised. Let the skin then be only divided, so as to allow it to descend a little in the lower part of the eye; which will be the consequence of the wound's gaping above. Let lint be put into it to prevent the union of the divided skin, and to generate a little flesh in the middle; and when this has filled up the part, the eye is afterwards properly covered by the eye-lid.

Of an ectropium.—As it is a disorder of the upper eye-lid not to descend far enough to cover the eye, so there is a disease of the lower, in which it is not raised high enough, but hangs down, and cannot be brought close to the other. And this also sometimes proceeds from a similar fault in the cure, sometimes even from old age. The Greeks call it ectropium (from turning outward). If it happens from a faulty cure, the treatment is the same as in the foregoing case; only the horns of the wound are turned towards the cheeks, and not to the eye. If it proceed from old age, the whole of it must be cauterized externally with a thin plate of iron; then anointed with honey; and from the fourth day fomented with hot water, and anointed with medicines to bring on a cicatrix.

Of the staphyloma.—These then are the general disorders, that commonly occur in the parts about the eye, in the angles, and eye-lids. In the eye itself the external coat is sometimes raised, either from the rupture or relaxation of some of the internal membranes; and it resembles a raisin stone in its form, whence the Greeks call it a staphyloma. There are two methods of cure for it. One is to pass through the middle, at the root of it, a needle with a double thread; then to tie tight the ends of one of the threads above, and of the other below; which, by cutting it gradually, may bring it off. The other is, to cut out from its surface about the bigness of a lentil; then to rub in spodium or cadmia. When either of these is done, the white of an egg must be spread upon wool and applied; and afterwards the eye must be fomented with the steam of hot water, and anointed with mild medicines.

Of clavi.—Callous tubercles in the white of the eye are called clavi; which name is given them from their figure. The best method is to pierce them at their very roots with a needle; and below that to cut them off, and then to anoint with mild medicines.

Description of the eye.—I have already elsewhere mentioned a cataract, because when recent, it is often removed by medicines. But when it is of long standing, it requires a manual operation, and one, which may be reckoned amongst the nicest. Before I treat of this, I shall give a short account of the nature of the eye; the knowledge of which, as it is of importance in several other parts, so it is peculiarly necessary here. The eye, then, has two external coats; the exterior of which by the Greeks is called ceratoides; and this, where it is white, is pretty thick, but before the pupil is thinner. The interior coat is joined to this, in the middle where the pupil is, and is concave, with a small aperture; round the pupil it is thin, but at a distance from it, something thicker; and by the Greeks is called choriodes. As these two coats surround the internal part of the eye, they again join behind it, and becoming finer, and uniting together, pass through the opening, which is between the bones, to the membrane of the brain, and are fixed to it. Under these, in the part where the pupil is, there is void space; then again below is an exceeding fine coat, which Herophilus called arachnoides, the middle part of which subsides, and in that cavity is contained somewhat, which, from its resemblance to glass, the Greeks call hyaloides. This is neither liquid nor dry; but seems to be a concreted humor; from the color of which, that of the pupil is either black or grey, though the external coat be white. This is enclosed by a small membrane, which proceeds from the internal part of the eye. Under these is a drop of humor, resembling the white of an egg, from which proceeds the faculty of vision. By the Greeks it is called chrystalloides.

*Of a cataract.**—Now a humor concretes under the two coats, where I mentioned the void space to be, either from a disease, or a blow; and being gradually indurated, it obstructs the interior faculty of vision. There are several species of this malady, some of which are curable, and others not. For if the cataract be small, immovable, of the color of sea-water, or burnished iron, and leaves some sense of light on its sides, there remains hope. If it is large, if the black part of the eye, losing its natural appearance, is changed into some other, if the cataract be of the color of wax or gold; if it slides and moves to and fro, it is scarcely ever cured. And for the most part, the more severe the disease, or the greater the pains of the head, or the more violent the blow has been, which gave rise to it, so much the worse it is. Neither is old age a proper time of life for a cure, which, without an additional disease, causes a dimness of sight; nor even childhood; but the middle age between these. Neither is a very small eye, nor one that is hollow, fit for this operation. And there is also a certain maturity of the cataract itself; wherefore we must wait till it seems to be no longer fluid, but to have concreted with a certain degree of hardness.*

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* See footnote to "hypochysis," in this article *supra*.

Before the operation, the patient must use a spare diet, drink water for three days, the day immediately preceding take nothing at all. After this preparation, he must be set in a light place, in a seat facing the light, and the physician must sit opposite to the patient, on a seat a little higher, an assistant behind taking hold of the patient's head, and keeping it immovable; for the sight may be lost forever by a slight motion. Moreover, the eye itself, that is to be cured, must be rendered more fixed by laying wool upon the other, and tying it on. The operation must be performed on the left eye by the right hand, and on the right eye by the left hand. Then the needle sharp-pointed, but by no means too slender, is to be applied, and must be thrust in, but in a straight direction, through the two coats, in the middle part between the black of the eye and the external angle opposite to the middle of the cataract, care being taken to wound no vein. And it must not be introduced with timidity neither, because it comes into a void space. A person of very moderate skill cannot but know when it arrives there; for there is no resistance to the needle: when we reach it, the needle must be turned upon the cataract, and gently moved up and down there, and by degrees work the cataract downward below the pupil; when it has passed the pupil, it must be pressed down with considerable force, that it may settle in the inferior part. If it remain there, the operation is completed. If it rises again, it must be more cut with the same needle, and divided into several pieces; which when separate, are both more easily lodged, and give less obstruction. After this the needle must be brought out in a straight direction, and the white of an egg spread upon wool must be applied, and over that something to prevent an inflammation, and then the eye be bound up.

Afterwards there is a necessity for rest, abstinence, mild unctuous medicines, and food (which it is soon enough to give on the day following) at first liquid, that the jaws may not be too much employed, then, when the inflammation is gone, such as was directed in wounds. To which we must add this rule, that the patient's drink be water for a pretty long time.

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* See footnote to ''hypochysis,'' in this article *supra.*

Of a flux of gum.—I have already treated of a flux of thin gum, which infests the eyes, so far as the cure depends upon medicines. I now come to these cases that require manual operation. Now we observe that some people's eyes never grow dry, but are always moistened with a thin humor; which circumstance occasions a constant asperity, and from slight causes excites inflammations and lippitudes, and, in fine, renders a person uneasy all his life. And this disorder in some no remedy can relieve; in others it is curable. Which difference ought, first of all, to be known, that we may relieve the one, and not meddle with the other.

And, in the first place, it is in vain to attempt the operation in those who have this disorder from their infancy, because it will certainly continue to their dying day. Secondly, it is needless, where the discharge is not great, but acrid; because they are not assisted by a manual operation, but are brought to a sound state by medicines, and a proper diet for generating a thicker phlegm. Broad heads also are hardly susceptible of the remedy. Then it makes a difference whether the gum be discharged by the veins, that lie between the skull and the skin, or by those between the membrane of the brain and the skull; for the former moisten the eyes by the temples; the others by the way of those membranes that go from the eyes to the brain. Now, a remedy may be applied to those veins, that discharge above the bone, but not to those below the bone. Neither can relief be given where the discharge comes from both places; because when one part is relieved, nevertheless the other remains disordered.

The source of the disorder is discovered by this method. After shaving the head, such medicines as stop the gum in a lippitude, ought to be laid on from the eye-brows as far as the top of the head; if the eyes begin to be dry, it appears that they are moistened by those veins, which are under the skin; if the moisture is not diminished, it is manifest it descends from below the bone; if a humor still flows, but in less quantity, the disorder is from both. In most patients, however, the complaint is found to be derived from the superior veins, and, therefore, the greater number ought to be relieved. And this is very well known, not only in Greece, but amongst other nations too; so that no part of medicine has been more clearly explained in any country.

Some practitioners in Greece cut the skin of the head in nine lines; two straight ones in the occiput, one transverse above these; then two above the ears, one also transverse between them; and lastly, three straight ones between the top of the head and the forehead. Others drew these incisions in a straight direction from the top of the head to the temples; and discovering from the motion of the jaws the origins of the muscles, made gentle incisions in the skin above these, and separating their lips by means of blunt hooks, they inserted lint in such a manner, as to prevent the edges of the skin from uniting, and to cause flesh to sprout up in the middle, which might bind those veins, from whence the humor passes to the eyes. Others again have drawn a line with ink from the middle of one ear to the middle of the other, and another line from the nose to the crown of the head; and where these lines met, made an incision with a knife; and after the effusion of blood, cauterized the bone in that part. And, notwithstanding this, they also applied the actual cautery to the rising veins both in the temples, and between the forehead and crown of the head.

It is a common method of cure, to cauterize the veins in the temples, which, indeed, are generally turgid in this kind of disorder; but that they may be more inflated and show themselves better, the neck must be tied pretty straight. And the veins must be cauterized with small and blunt irons; till the flux of gum upon the eyes stop; for that is a sign that passages are blocked up, by which the humor was conveyed.

However, it is a more effectual method, when the veins are small and lie deep, and, therefore, cannot be separated, to make a ligature about the neck in the same manner, and the patient keeping in his breath, that the veins may rise the more, to mark with ink these in the temples, and between the crown of the head and the forehead; then loosing the neck, to cut the veins, where these marks are, and discharge blood; when a sufficient quantity has flowed, to cauterize them with small irons; in the temples, indeed, with caution; lest the muscles lying below, which secure the jaws, be hurt; but between the forehead and the crown so strongly, that a scale may cast off from the bone.

But the method of the Africans is still more efficacious, who cauterize the crown of the head to the bone, so as to make it cast off a scale. But nothing is better than what is done in Gallia Comata, where they separate the veins in the temples, and the upper part of the head. The manner of treating cauterized parts I have already explained. At present I shall add this one direction: that when veins are cauterized, we should not endeavor to hasten the separation of the eschars, nor the filling up of the ulcers; lest either a hemorrhage ensue or the pus be quickly suppressed; since it is fit these parts be dried by the latter, and it is not proper they should be exhausted by the former. If, however, a hemorrhage should at any time happen, medicines for stopping blood must be rubbed in, but not such as will prove caustic. Now, the method of separating veins, and what is to be done when they are separated, I shall explain, when I come to the varices of the legs.*—(T. H. S.)

Celsus' entropion operation. This ancient procedure consisted in the removal of a fold of skin from the lid, combined with a horizontal incision of the conjunctiva.

Celsus' epilation method. This procedure consisted in removing inverted cilia by destroying their roots with a thin, red-hot, broad needle. Later, Ambrose Paré invented a similar needle fixed in a steel ball and used for the same purpose.

Cement. When this substance contains lime—as it usually does—and gets into the eyes, the cauterant effects of the calcium salts may be produced. For example, Andreae (*Die Verletzungen des Sehorgans durch Kalk,* 1899) mentions a case of a patient into whose eyes some powdered Portland cement had been blown. This substance, which is a double silicate of calcium and aluminum, produced a keratitis followed by corneal opacities, which finally ended in a marked symblepharon.

Cemented bifocal lens. See **Bifocal.**

Cement-substance. This term is commonly applied to that albuminous, semi-fluid substance which in the crystalline lens not only unites the individual lens-fibres with one another, but is believed to exist (for the same purpose) beneath the anterior epithelium and between the ends of neighboring fibres along the sutures. See **Anatomy of the eye.**

Cendre. (F.) Ashes; cinder.

Centaurea, Amblyopia, from. CORN FLOWER. Benedict (*Handbuch d. Augenheilk.,* Vol. 5, p. 96, 1825) asserts that preparations of this plant when taken in large amounts are capable of producing amaurosis, but there does not seem to be any further evidence of its oculo-toxic effects.

Centaurea cyanus. (L.) The corn-flower. The juice of the flowers was formerly employed in the preparation of collyria.

Center, Ciliospinal. See **Centrum ciliospinale.**

Center, Color. A cortical area for color perception, said to be situated in the cerebral occiput, anterior to the apical region. See **Centers, Visual**; and **Color sense.**

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* The method was to split the skin over the vein, and then, if a vessel were straight or only moderately crooked, to cauterize it, but, if it were exceedingly tortuous "and, as it were, twisted into orbs," to take it up on hooks and cut it out.

Centering. In *optics,* having the pupil and the optical center of a lens in the same axis. In *microscopy,* the arrangement of an object so that its center coincides with the optical axis of the microscope.

Centering and adjustment of glasses. See **Eyeglasses and spectacles, Mechanical adjustment of**; also **Centration and adjustment of lenses.**

Centering machines. Although simple devices for the centering of ophthalmic lenses are in use yet many of them are quite elaborate, accurate, and expensive. Centering machines are pictured in Pettet's *The Mechanics of Fitting Glasses,* pp. 62-64.

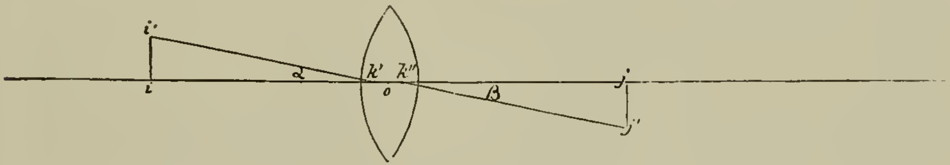
Centering of the eye. The points at the center of curvature of the refracting surfaces of the eye do not in general lie in a straight line; usually the center of the curvature of the cornea lies somewhat under the axis of the lens. As Hess and Tscherning have shown, the centering changes upon marked accommodation through slight changes in position of the lens. No marked disturbance of sight occurs because of faulty centering of the eye.

Center of lens. A point on the axis of a lens where the line joining the extremities of two parallel radii of its two surfaces cuts the axis.

Center of motion of the eye. According to Donders (*Accommodation and Refraction of the Eye,* p. 180), numerous investigations of this subject have been made, among others by Volkmann, Mile, Burow and Valentine. These investigations yielded rather discordant results, but as the eye does not differ much from a globe, and is in great part contained in a globular cavity, these observers agreed that the center of motion should be situated about in the middle of the visual axis. The discrepancy of the results obtained is attributable in part to the methods of investigation employed, but in part, no doubt, also to differences in the eyes themselves. Since, in fact, it was shown, that ametropia depends principally on a difference in length of the visual axis, it must even *a priori* have been supposed, that the distance at which the center of motion lies behind the cornea, should, in ametropia undergo a modification. The length of the visual axis in emmetropic individuals is supposed to be 22.231 mm. Now by the method adopted the distance from the center of motion to the base of the segment of the cornea (this base being 2.6 mm. from the apex of the cornea) 2.6 mm. must be added to the number obtained, in order to find the position of the center of motion behind the apex of the cornea. The same determinations were made in ametropia. Consequently, it appears (1) that in the emmetropic eye the center of motion is situated at a considerable distance (1.77 mm.) behind the middle of the visual axis. (2) That in myopic individuals the center of motion is situated more deeply in the eye, but also farther from the posterior surface, and indeed so that in the eyes of such persons the relation between the parts of the visual axis, situated before and behind the center of motion, is nearly the same as in the emmetropic eye. (3) That in hypermetropic eyes the center of motion is situated not so deeply, but relatively very much closer to the posterior surface of the eye.

Center of rotation. When the eye fixes an object the point about which it revolves is called the center of rotation and lies 14 mm. behind the cornea. See **Physiological optics.**

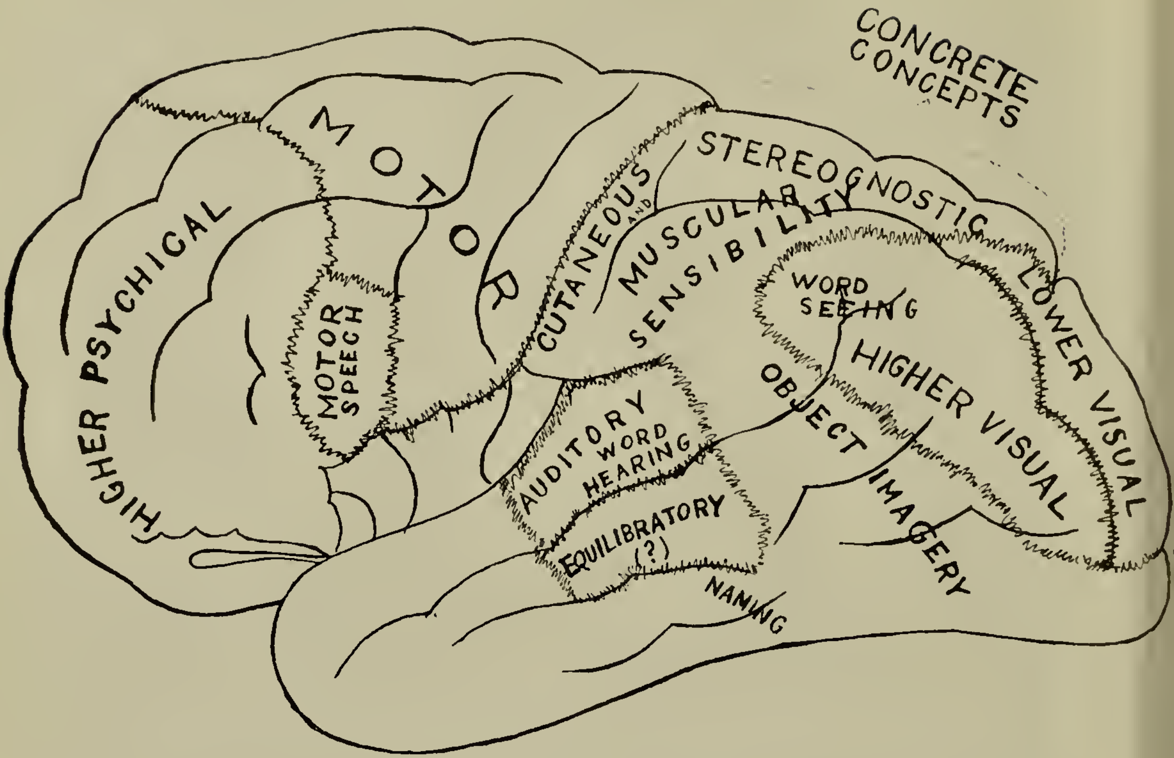
Center, Optical. In the figure the point "*O*" represents the optical center of the lens. It is assumed that the rays pass unrefracted through this center.



Optical Center of a Lens.

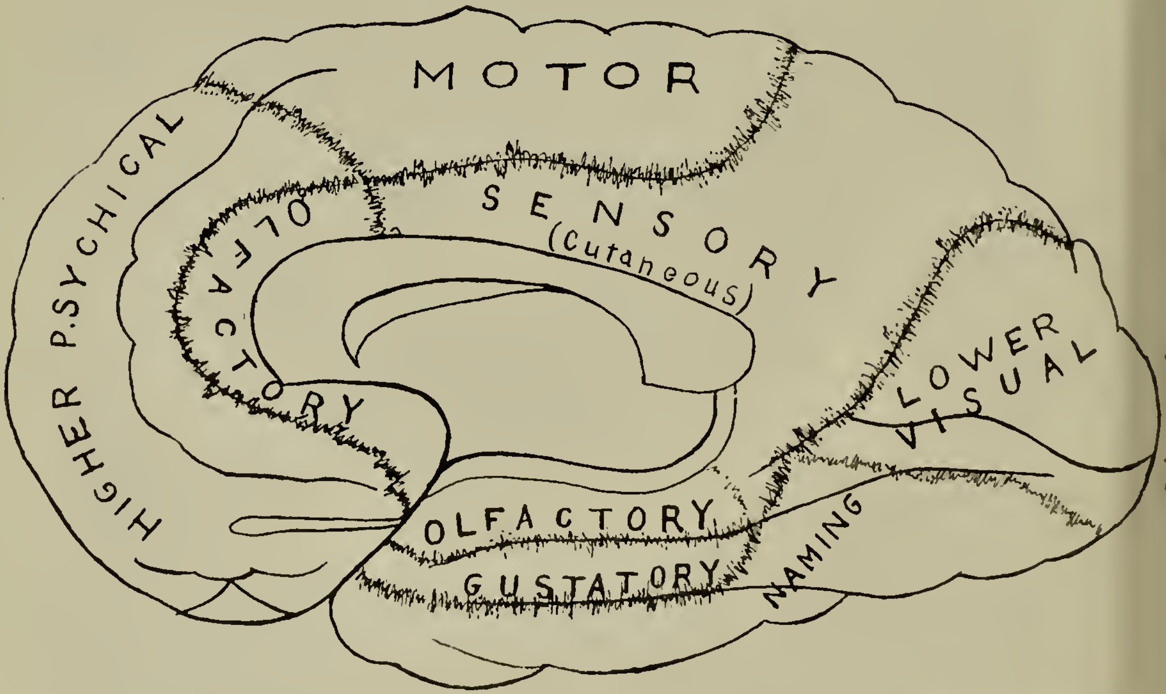
Center, Pupil-dilating. A cortical area probably exists in the posterior end of the first and second gyri. See **Pupil in health and disease; Intracranial organs of vision**; and **Neurology of the eye.**

Centers, Visual. The cortical center for form, and (perhaps) for color sensations, lies in the region of the calcarine fissure. This was quite definitely settled by Henschen (*Klin. u. Anat. Beiträge z. Path. d. Gehirn.* Upsala, 1892) who showed that the nervous fibrils of the visual track lie close to the posterior margin of the internal capsule, as a more or less compact bundle. This collection of nerve fibres runs horizontally at about the level of the second temporal convolution; and then passes to a cortical area situation at the upper margin of the calcarine fissure, while the lower portion descends to its lower margin. So far as the retina is concerned the upper cortical fibres correspond to the upper quadrants of the retina; the lower to the lower quadrants. It is quite likely that the cortical center in the macular region lies anteriorly to and at the bottom of the calcarine fissure; also that the periphery of the retina is represented by those fibres that lie posteriorly. Each macular region is supplied from both cortical centers that correspond to the half of each retina on the same



Side View of the Human Brain, Showing Localization of Functions.

(After Charles K. Mills.)



View of the Mesial Surface of the Human Brain, Showing Localization of Functions.

(After Charles K. Mills.)

side. The *visual memory* center—where visual impressions are not only received but stored up for future use—lies in the convolutions of the outer surface of the occiptal lobe, immediately above the cuneus. The relations of the visual centers to both cortical and subcortical areas are shown in the accompanying diagrams. See, also, **Intracranial organs of vision.**

Centers, Word. In all probability there are several cerebral cortical centers for verbal expression. If so, one of these is in the left superior temporo-sphenoidal gyrus, which exercises control over the perception of words heard. Another is in the posterior aspect of the left parietal lobe, and still another in the second, left, frontal gyrus governs the perception of printed or written words. See **Neurology of the eye**; and **Intracranial organs of vision.**

Center, Winking. The reflex center concerned in winking is probably situated in the medulla oblongata.

Centoculated. Having a hundred (or many) eyes.

Centoculous. Having a hundred or numerous eyes. Centoculated.

Centrad. In *ophthalmology,* a unit of prismatic power, suggested by W. S. Dennett, equal to 0.01 of the *radian,* which is the angle subtended at the center of a circle by an arc equal in length to the radius. The centrad is, therefore, 1/100th part of the arc of 57° 17′ 44″. 80625, and in the smaller arc-values, is nearly equal to the *Prism-dioptry.*

Centradiaphanes. Cataract due to opacity in the central portion of the crystalline lens.

Centrage. Centering. The condition in which the centers of all the refracting surfaces of the eye fall in the same straight line.

Central amblyopia. This expression is generally used in connection with Leber's disease. See **Amblyopia, Central.**

Central artery, Obstruction of the. Plugging of the central artery of the retina was first described in 1859 by von Graefe. The symptoms and ophthalmoscopic signs are well known—narrowing of the retinal vessels, the cherry-red macular region, the edematous area corresponding to the starved retina, the scotoma in the field of vision, and the association of these conditions with diseases of the heart, advanced arteriosclerosis or aneurysm of the carotids, etc. The best description of retinal obstruction is that of Coats in the *Royal London Ophthalmic Hospital Reports* for 1905, p. 3. See the major headings, **Thrombosis of the central artery of the retina**; and **Embolism of the central artery of the retina.**

Central artery of the retina. This important vessel is partially described under **Artery, Central, of the retina.** According to Salzmann and Brown, the *arteria centralis retinæ* enters the optic nerve 7 to 12 mm. [according to Meyer 15 mm.] behind and below the bulb. It first supplies the neighboring portions of the sheaths, then its immediate neighborhood in the optic nerve, in the axis of which it courses farther on to the bulb. Its part in the supply of the optic nerve is, therefore, a minor one; only at the *lamina cribrosa* does it give off a larger number of fine branches. Here and in the intrachoroidal section of the optic nerve the last capillary anastomoses between the retinal and the ciliary vessel systems are found, but from the inner end of the optic nerve canal on, the retinal is completely separated from the ciliary system, as a rule. This portion of the *arteria centralis retinæ* is an end artery in the sense of Cohnheim, and, furthermore, all of the blood carried by the *arteria centralis retinæ* is carried away by the *vena centralis retinæ.* The *arteria centralis retinæ* divides into an upper and lower main branch *(arteriæ papillaris superior et inferiores)* on the inner surface of the papilla and these, again, into a nasal and temporal branch *(arteriæ nasales super. et inf., arteriæ temporales super. et inf.).* ·Yet even in respect to the branches of the second order there rules a significantly lessened regularity. Under further gable-like divisions the arteries broaden out into the retina mostly in a radial direction; the temporal branches alone course in wide bows above and below the fovea and, converging, send fine branches to the fovea. Finally, as a rule, a few fine branches go directly over the temporal border of the papilla to the fovea.

Centralblende. (G.) Diaphragm between two lenses.

Centralcanal des Glaskörpers. (G.) Hyaloid canal.

Central cataract. See **Cataract, Nuclear.**

Central choroiditis. Inflammation of the choroid confined to the region of the macula may appear either as a senile change or in young persons without particular causes. When bilateral and occurring in infants it has an injurious effect upon the mental development of the child. The eyes are amblyopic and nystagmic; and the facial expression is suggestive of idiocy. Older subjects complain of loss of vision and the presence of a central scotoma. Ophthalmoscopic examination shows the presence of an exudation in the macular area, if the case is seen early; if examined at a later period, a large, white, atrophic area, bordered with pigment, is found. The disease, both in the infantile and senile forms, is sometimes found in several members of a family.

In elderly persons the ophthalmoscopic signs may consist of a round or oval area at the macula, presenting yellowish, erosion-like dots and pigmentary changes, minute hemorrhages, and crystals of cholesterin; or the macula may look as though salt and pepper had been dusted upon it. Hutchinson and Waren Tay, described a condition of the fundus, known as ''Tay's choroiditis,'' or ''central senile guttate choroiditis,'' in which the macular area is filled with closely set, pale-yellowish dots. This condition which was supposed to be found only in middle-aged and elderly persons, has been observed at all ages, and is similar to punctate conditions found in the retina. It is to be distinguished from colloid disease of the macular region. Another form of central choroiditis has been named senile areolar atrophy of the choroid, in which, owing to atrophy of the pigment layer, the stroma of the choroid and the curves and anastomoses of its vessels can be plainly seen. Such a case may present the vessels as atrophic white lines (sclerosis of the choroidal vessels). The failing vision of elderly persons in whom the dioptric media are clear is often due to central choroiditis; and this condition may be a cause of great disappointment after a technically successful cataract extraction.—(J. M. B.) See **Choroiditis in general.**

Central color-scotoma. This defect in the visual field is associated not only with disease of the tissues of the macular region, but with retrobulbar neuritis, toxic amblyopia, and other conditions affecting the nerve fibrils supplied to the fovea. Color scotomata are generally spoken of as *relative,* and for their detection colored papers are generally used as test objects on the perimeter. If the defect is only partial the color will appear not so bright at the point of fixation as at the side of it, in which case light shades of the test colored object should be used. This important subject will be more extensively treated under **Examination of the eye**; and **Color sense.**

Central fovea. According to Dwight, this funnel-shaped depression is situated near the center of the yellow spot and nearly in the axis of the globe. It is at an average distance of 3.915 millimetres from the center of the optic disk and 0.785 millimetre below the horizontal meridian (Landolt), a distance which varies according to the shape of the ball, being greater in hypermetropes and less in myopes. It is the region of most acute vision, and it is because of the localized character of this acuity that the eye must be moved when scanning carefully a surface of any extent. Its diameter is from 0.2 to 0.4 millimetre, and it is so deep that the retina at its bottom or fundus is thinner than at any other place, being only 0.1 to 0.08 millimetre thick. With the ophthalmoscope it can usually be discerned as a clear speck situated in the darker area of the yellow spot. Kuhnt describes a flat area—fundus-fovea—at the center of the fovea, and exactly in the middle of this a small concave depression called the foveola. Dimmer says that this fundus foveola is found only in large flat foveæ.

The layer of rods and cones is greatest in the middle of the fovea centralis, the longest and slenderest cones being found in the foveola. The foveal cones resemble rods more than they do the other cones, but their conic nature is evidenced by the absence of visual purple. In the center of the fovea is a minute area having only cones. Its diameter is about 0.5 mm. The slenderer cones are found only in the midst of this district, and are irregularly placed. Towards the border the cones are thicker and arranged in oblique rows. Outside of this field the rods appear, at first mixed with cones, finally, they become united into a simple circle about each cone. See **Fovea centralis.**

Central Gefässe der Netzhaut. (G.) Central vessels of the retina.

Central green spot. This macular phenomenon is analogous to or identical with the brown or black spot seen in a certain percentage of myopic individuals.

Bietti (*Klin. Mon. f. Aug.*, 50, II, Nov., 1912, p. 530) believes that while Butler attributed the green spot to the formation of a hole caused by stretching of the parts and to changed coloring matter in the supply of blood, he reports a case which seems to him to support the theory of Stargardt and Lehmus, who ascribe the phenomenon to a proliferation of the pigment epithelium. If the epithelium contains pigment, the spot is black; if it is devoid of epithelium, green. As there was in the instance referred to no difference of level, the existence of a hole was excluded. See **Black spot about the macula.**

Central ptosis. According to Swanzy (*System of Diseases of the Eye,* Vol. 4, p. 586), a separate cortical centre for the nerve supply of the *levator palpebræ* and *orbicularis palpebrarum* exists, and this is not inconsistent with the fact that, as regards the motions of the eyeballs, associated centres alone are present; for although, as a rule, the elevators of the eyelids are associated in their motions, yet by an effort of the will most people can throw one of them into motion separately, or more than the other. The power to innervate voluntarily one levator and orbicularis alone varies in different individuals, and Nothnagel leans to the opinion that in many persons the levator centres are practically associated centres, and that, consequently, central ptosis is rarer than it otherwise would be. The centre for the levator palpebræ is believed to be in front of the upper extremity of the ascending frontal convolution, close to the arm centre; and, as in the motor zone for the extremities there is present the centre for sensation in those parts, so, probably, the centre for the levator palpebræ contains the cortical centre for that portion of the fifth nerve which supplies the surface of the eyeball. A destructive lesion of this centre causes ptosis of the opposite upper eyelid; and the conjugate motions of the eyeballs, which physiologists have obtained on stimulation of this same centre, may have been similar to the voluntary motions of the eyeball, which take place on irritation of the skin of the eyelids, or of the surface of the eye. Bruns, Landouzy, and Wernicke believe this centre to be in the inferior parietal lobule. Central ptosis is not a very uncommon symptom, and it is probably often a distant symptom.

Central retinitis. This term is applied to a number of diseases of the retina, inflammatory and other. It is, however, chiefly used to indicate the *central punctate diabetic retinitis* of Hirschberg, a good description of which is given by Schöbl (*System of Diseases of the Eye,* Vol. 3, p. 510). He describes this type of retinitis as occurring without swelling or cloudiness of the papilla; nor is the retina diffusely opaque or edematous. At the posterior pole of the fundus, especially in the macular region, are found numerous ivory-white points, spots, and stripes which surround the macula in an irregular manner without forming the regular radiating or star figure which is presented in albuminuric retinitis. These spots are round or oval or are irregular in outline; sometimes they are linear or semilunar in shape. Their margins are often serrated. Smaller aggregations of these spots are seen between the macula and the optic nerve head up to the superior and inferior temporal vessels of the retina. Beyond these vessels they may appear as single spots, but they are much rarer on the nasal side of the disk. Some of them cover small blood-vessels, which shows that they lie in the nerve-fibre layer. Rarely a blood-point is seen in one of them. Larger white spots are of very infrequent occurrence. They appear to remain unchanged for years; their number may increase, yet they never coalesce and form large plaques or group themselves around the macula in radii. Everywhere between these white areas fine blood-points, stripes, or little spots (and rarely somewhat larger hemorrhages) may be seen. These blood-spots usually reach farther to the periphery than the white spots; they also extend farther on the nasal side of the disk and beyond the temporal vessels. The periphery of the fundus appears normal; there are no pigment alterations. The vitreous does not contain any opacities or hemorrhages.

Central scotoma. The region of the macula may be the seat of destructive disease when, at the same time, there are no defects as regards light, intensity, form, etc., in other parts of the visual field. These defects are called *central scotomata.* When the light-sensibility of the retina is lost at the foveal region there is no central fixation-point, and in making perimetric examinations the next most sensitive area of sensation should be chosen as a fixation-point. Wilbrand (Norris and Oliver's *System,* Vol. 2, pp. 197, 8, 9), advises that if the diseased eye has not acquired a squinting position, and if the other one is normal, the perimeter be placed in front of the eccentrically fixed eye in the usual manner, and the normal eye be left uncovered. The patient is then asked to fix his gaze on the spot on the perimeter. It will be then found that the diseased eye, through the sympathetic influence of the normal eye, takes the proper position. The sound eye can then be covered, and the examination continued as long as a proper position is maintained. By repeatedly removing the cover, and so regaining the proper position, a field of vision which exactly answered the physiological requirements can be obtained during the intervals. In a case where both eyes are eccentrically fixed, the patient can be asked to place his index finger on the fixation-point, and told to gaze at the spot where the tip of his index-finger touches.

When all light-sensation has disappeared within the central defect, it is spoken of as an *absolute central scotoma.* If the defect shows itself for one or all colors, and no defect is proved for the smallest white objects, it is known as a *relative central scotoma.* The terms *indistinct* and *inaccurate* central scotoma are used to signify that condition in which, although the color-impression prevails in the centre of the field of vision, its tint undergoes a modification. Besides this classification of absolute central scotomata, relative central scotomata, and indistinct central scotomata, central defects of field of vision may be divided after Förster's method into positive and negative central scotomata. In *positive central scotomata* the patient perceives a dark spot in the field in place of the fixation-point. *Negative central scotomata* are not recognized as scotomata, the patient perceiving a blurred and indistinct image. Central scotomata are also divided, according to their position in relation to the point of fixation, into *pericentral scotomata,* where the fixation-point lies in the centre of the scotoma, and *paracentral scotomata,* where the field lies on the edge of the scotoma. It is of great importance to observe whether these central scotomata appear on one or both sides, and if they are observed simultaneously in both eyes. Among the *bilateral paracentral scotomata* the *tem-*

poral hemianopic and the *homonymous hemianopic* types play an important rôle, because the point of fixation remains intact. The first groups of central scotomata lie in the temporal half of the field of each eye outward from the fixation-point. The bilateral central scotomata may be either on the right or the left side of each eye, but are always on the same side of the point of fixation. A peculiar form is the *central scotoma of fatigue,* which is observed only in functionally nervous conditions.

Central scotomata may be produced by chorio-retinal changes in the macular region, and then they are mostly positive; or they may be produced by a disease of the papillo-macular bunch of fibres of the optic nerve, and then they are negative in character. An affection of the papillo-macular bunch of fibres in the chiasm produces a double-sided temporal hemianopic scotoma. An isolated lesion of the papillo-macular fibres of a tract of the optic radiations and of the macular cortical field produces an homonymous hemianopic paracentral scotoma. The hemianopic paracentral scotoma also belongs to the negative group. Even if colored objects, on account of their feebler brightness, form a much more sensitive test for existing disturbances in the field of vision than white ones, yet they do not suffice if it is desired to determine the real extent of a central scotoma. The reason for this is that it is difficult to fix the exact limits of such scotomata, because the absolute types are generally surrounded by a zone of diminished sensibility, in which, for instance, a red square appears as dark-red or brown through all varying shades from red to black. Again, the determination of colors depends upon a certain arbitrariness of the examiner and the patient, because it is placed at the option of both of them to decide which tint they still regard as red. To obviate this, the acuteness of vision for points is employed as a still more precise test. Especially is this so if in a case of diminished central acuteness of vision no central scotoma is found for the smallest colored objects, or if in a case with autopsy the field-defects can be compared with the microscopical preparations of the cross-section of the optic nerve. In this latter instance it is of importance to know where the function was missing in the field of vision, in order to determine the position of certain bunches of optic-nerve fibres. The determination of the exact boundaries of a relative central scotoma always offers some difficulties, even to the experienced observer; still, it is easier for the patient to state if he sees a black point than to determine exactly the tint to which a color-object has turned. See, also, **Field of vision.**

Central theory of strabismus. This theory denies the explanation of Donders, that the origin of squint is to be found simply in the intimate relations of accommodation and convergence. The opponents of this idea insist upon the importance of an affection of the central nervous system, especially in connection with binocular vision. In other words, the innervation of convergence and accommodation is regarded as of more importance than that of the mechanics by which they are brought about. Fusion of the macular images in the two eyes, producing binocular and single vision, is the most important ocular function disturbed or made impossible in strabismus; the fusion faculty is to be considered rather than the purely muscular anomaly.

Central vein of the retina. The distribution of the central vein closely follows that of the accompanying artery, and it is well to remember that it is united to the central connective-tissue strand by an extension of the pial sheath. Eventually it empties directly into the cavernous sinus (q. v.). The minute venous capillaries supplied to the retina that join to form the central vein are from two-fifths to three-fifths mm. in diameter. Branches of the central artery of the retina are lighter in color and generally more tortuous than the veins, and are about one-third smaller than the latter. In their passage from the papilla of the periphery of the retina, as the ophthalmoscope shows, they usually pass over the veins. The central white streak, or light-reflex, is less marked in the veins than in the arteries. As Gould long ago pointed out "The arteries often pass spirally around the veins once, or even twice, near the disk. As the veins dip down over the edge of the cup of the disk, a distinct pulsatory movement is frequently seen at this point synchronous with the cardiac beat. This phenomenon—the venous pulsation—is physiologic, and should not be confounded with the rare pathologic pulsation of the arteries in the same position. The division of the main central artery into two branches, the superior and inferior, usually occurs before its emergence upon the papilla, and these two principal trunks undergo dichotomous subdivision into temporal and nasal branches, and others, as they progress towards the peripheral parts of the retina. Corresponding coalescences of the peripheral capillaries of the veins occur on approaching the disk, until all unite in the two chief trunks that enter the optic nerve. The main trunk may, also, subdivide after it's exposure upon the disk, or the superior and inferior branches of the vein may unite before disappearing from view."

Central vein of the retina, Thrombosis of the. In early reports of obstruction of the central vessels of the retina certain well-marked ophthalmoscopic appearances (really due to venous thrombosis) were credited to embolism of the central artery or to some form of retinitis. Probably some of the reported cases of hemorrhagic retinitis were examples of thrombosis. Phlebitis of the cavernous sinus, which might be expected to cause ophthalmoscopic signs, rarely does so because of the free communication existing between the orbital and facial veins.

In complete closure of the central vein by a thrombus the retinal veins are dilated and tortuous, the margins of the optic disc are blurred and indistinct, but the disc itself is usually not much swollen. Around the disc is a striated area of blood-extravasation into the nerve-fibre layer of the retina; and numerous hemorrhages are found in the periphery. The arteries are small and few in number. The veins may show on their convexity a light-streak, while the concavity is hidden in the edematous retina. Vitreous opacities soon appear, and vision becomes much reduced. In favorable cases the vitreous clears, the hemorrhages disappear by absorption, and useful vision may be retained. Some cases show in the macular region a yellowish-gray opacity presenting a cherry-red spot in its centre. Such cases simulate embolism. Vision may be completely lost in thrombosis by repeated hemorrhages. If the thrombus becomes dissolved or a canal forms alongside it, the fundus will gradually become clear.

In incomplete closure of the central vein or in closure of one of its branches, a less extensive, but similar, retinal picture is seen. There are a few hemorrhages on the disc-margin or in a peripheral part of the retina. There may be in the mildest cases only a few tuft-like hemorrhages radiating from the disc. Such cases may improve and visual acuity may be restored. Often, however, such lesions occur repeatedly, and glaucomatous symptoms supervene, the case ending in an enucleation for the relief of pain. In thrombosis of a branch of the central vein the retinal changes are limited to a corresponding area.

The *diagnosis* of thrombosis of the central retinal vein may present many difficulties. The following table by Frost contrasts the ophthalmoscopic appearances of thrombosis and embolism:—

THROMBOSIS OF THE CENTRAL VEIN.	EMBOLISM OF THE CENTRAL ARTERY.
1. Arteries: calibre normal or slightly diminished.	1. Arteries filiform.
2. The veins are tortuous.	2. Course of veins normal.
3. Veins turgid, and appear interrupted (from being buried in the retina).	3. Veins decrease toward the disc (blood-column may be broken into segments).
4. Venous pulsation on pressure.	4. No pulsation.
5. Extensive retinal hemorrhage.	5. No hemorrhages, or very few.

The prognosis will depend on the location of the thrombus and whether it becomes speedily dissolved or remains, completely occluding the lumen of the vessel. In general terms it may be said that complete restoration of visual acuity is scarcely to be expected.

Treatment is unsatisfactory. Venesection, rest, and the use of salines may be tried.—(J. M. B.)

Purtscher has reported the case (*Klin. Mon. für Aug.*, 51, I, January, 1913, p. 63), of a woman, aged 70, who two weeks before awoke almost blind in the left eye, which had never been diseased before. Vision was reduced to counting fingers at ¼ m. The writer found a thrombosis of the lower branch of the central vein, the borders of the disc ill-defined, the veins ectatic and tortuous, and some retinal hemorrhages. Iodide of potash was prescribed.

Two days later the patient was seized with pneumonia of the left lower lobe, with slight injection of the left eye. While the pneumonia ran a regular light course, the inflammatory symptoms in the eye increased.

About three weeks later when she came again to the clinic she had a severe iridocyclitis, exudations on the posterior surface of the cornea and in the pupil, hypopyon, with increased tension. Then a regular panophthalmitis developed, complicated with a typical ring abscess of the cornea. The bacteriological examination revealed pneumococci in the exudation, taken from the vitreous, and cultures, injected into mice, created a typical pneumococci septicemia.

The thrombosis produced a disturbance in the nutrition of the retina, analogous to that in contusions and bruises of the tissue from injuries with blunt objects. The germs from the second, entirely independent, disease circulating in the septicemic blood thus were conveyed to the necrotic tissue, which served as favorable soil for their further growth. As shown by Axenfeld, the pneumococci especially have the tendency to emigrate from the thrombosed vessel into the surrounding structures.

See, also, the major heading, **Thrombosis of the central vein of the retina.**

Central vision, Universal. George M. Gould has reported the case of a man who could read an entire page of a book at one single glance, and then, to prove that he had done so, would repeat the entire page *verbatim et literatim.* Gould examined him very carefully and found no central vision at all in one eye, but, in that eye, "macular" vision absolutely throughout all the rest of the field. The other eye had no peripheral vision, only central. The lapping of the two fields gave the man, in effect, central vision throughout the binocular field.

Similar cases have been reported before. Shastid suggests that this condition be called *universal central vision*, or *universal macularity*.

Central visual acuity. This expression is somewhat redundant because when "visual acuity" or "acuity of vision," or simply "vision" is spoken of the intent is to consider sight as it exists at the fovea or macular region.

Centration and adjustment of lenses. The need of proper centration and adjustment of eyeglasses and spectacles appeals to every ophthalmologist and there is, perhaps, no part of the work he is called upon to supervise or do that receives less attention. Many people are uncomfortable with glasses whose formula theoretically corrects their errors of refraction because of the lenses not being optically correct. M. R. Richards lays much stress upon "optically correct" and "mechanically correct" lenses. The "mechanical" center and the "optical" center of a lens may be very different. He insists that the oculist should visit his optician and acquaint himself with the latter's methods, and that he should insist upon his work being done in the most approved manner. The lens, after being cut in the rough, must be carefully marked with a modern five-dot machine with rotating cross lines on the dial. After the lens is edged it should again be marked on the same machine and, if a rimless glass, the post holes should be placed on the horizontal line thus found, not on the long axis of the oval, which would perpetuate any mistake made by the first operator. The operator who straightens the frame, before doing so, should again center and mark the base line of the lens with the same centering machine, and should see that a continuous horizontal line drawn across both lenses passes through both optical centers and the three horizontal dots on each lens, thus making the setting of the lenses optically correct. The finished product should be handed to a fourth operator, without any formula, and by means of a lens measure, test glasses and centering machine he should note on a piece of paper what he finds the formula of the glasses actually is. This paper, with the glasses should then be sent to the manager's desk, and then compared with the oculist's original prescription. The above method is now in use by thirteen opticians in and around New York City. The oculist should own a modern centering machine and before allowing patients to wear their glasses he should make an examination of the lenses as above outlined and then compare his findings with his original prescription.

To these injunctions might be added the following directions, which are used by several ophthalmic surgeons in Chicago and given to every patient with his prescription for glasses:—It is sometimes difficult for the doctor to decide whether the glasses ordered for the patient are satisfactory and are producing the results desired by him, until they have been worn for a time. It is in consequence particularly requested that for his own benefit *the patient return to the oculist after he has used his lenses for ten days (or for the period prescribed)* so that this important matter may be decided.

The whole subject will be discussed in all its theoretical and practical details under **Eyeglasses and spectacles, Adjustment of.**

Centre, Ciliospinal. See **Ciliospinal centre.**

Centre de courbure. (F.) Centre of curvature.

Centre, Geometrical, of a lens. The point on a decentered lens through which the axis of the system passes.

Centrifugal. Flying off, or proceeding from a centre.

Centrifugal pathway. Myotic tract. Efferent nerve path. This expression refers chiefly to the pupil-reflex and is intended to indicate the line of communication between the third or oculo-motor nerve and the sphincter pupillæ. When this pathway or the nerve centers connected with it are stimulated the pupil contracts; section of the communicating fibres produces dilatation of the pupil. See **Centripetal fibres of the optic nerve.**

Centripetal. Tending towards, or moving in the direction of, the centre.

Centripetal fibres of the optic nerve. In its fully developed state the optic nerve is formed of two sets of fibres—one of peripheral, retinal, or centripetal origin. Centrifugal nerve-fibres are of central or cerebral origin. Von Gudden has divided these fibres into large and small, but believes that both are afferent fibres, and that the larger optic fibrils carry visual impressions, and that the smaller constitute a portion of the mechanism for producing the pupil-reflex. Von Monakow (*Archiv für Psychiatrie,* Vol. xx, p. 780) believes that these two classes of optic fibres belong to two distinct systems; the larger ones arise in the large nerve-cells of the retina and grow centripetally into the external geniculate body and the optic thalamus. The smaller fibres, he thinks, originate in the cells of the superficial gray matter of the corpora quadrigemina and grow outward to terminate in the inner nuclear layer of the retina.

Centripète. (F.) Centripetal.

Centrocataracta. (L.) Central cataract.

Centrum ciliospinale. The centre for the sympathetic nerve, for the dilatator pupillæ and for the muscle of Müller lies in the lowest cervical and uppermost thoracic segments of the cord. In man these fibers leave the spinal cord with the anterior roots of the first thoracic nerves and perhaps in part also through the eighth cervical root. In experiments on cats, dogs and rabbits sympathetic fibres which dilate the pupil were found even in the seventh cervical and the second thoracic nerves. Budge, who discovered this centre, located it between the sixth cervical and the fourth thoracic vertebræ and called it the *centrum ciliospinale inferius* in contra-distinction to a second centre for dilatation which he suspected to exist higher up and which he called the *centrum cilio-spinale superius.*

Cephalalgia. Pain in the head.

Cephalic index. A term used in the science of anthropology to indicate the percentage proportion existing between the breadth and the length of a human skull. Retzius adopts 100 as the anterio-posterior diameter. The current classification of skulls upon this index is the following: hyperdolichocephalic, below 70; dolichocephalic, from 70-75; mesaticephalic, 75-80; brachycephalic, from 80-85; hyperbrachycephalic, above 85. These divisions are quite arbitrary, and unnecessarily minute. It may serve to indicate the general result of this classification to state that Eskimos, Fuegians, African negroes, Veddahs, Australian aborigines, Fijians, and certain races of Northern Europe are typically dolichocephalic; while aboriginal Americans, Malays, Mongols, Sandwich Islanders, Lapps, Finns, Poles, Tyrolese, etc., provide illustrations of brachycephalic skulls. The mesaticephalic crania are found among Japanese, as well as Chinese, Greeks, French, Germans, Danes, British, etc.

Cephalocele. This is one of the classes into which Berlin divides *orbital cysts*—the other being *true* cysts. Cephaloceles are located at the root of the nose and extend to the orbit, nasal cavities, or brow. As a rule they present at the nasal side of the orbit, are transparent and fluctuating. Evacuation of a cephalocele is often sufficient to cure it provided the cystic cavity is afterwards irrigated with an antiseptic, astringent lotion.

Cephalohemometer. (F.) An instrument to measure the quantity of blood going to the brain.

Cera. See **Wax.**

Cera citrina. See **Wax.**

Cérat. (F.) Cerate.

Cerata. See **Cerates.**

Ceratectasia. Ectasia of the cornea.

Ceratectomy. KERECTOMY. Excision of a portion or the whole of the cornea.

Cerates. CERATA. Cerates are unctuous solid preparations containing sufficient wax to prevent them from melting at the ordinary temperature of the body. Ceratum is made up of white wax, 30 parts, and lard, 70 parts; the other five cerates in the U. S. P. are combinations of wax and lard with some medicament.

Ceratiasis. KERATIASIS. A morbid condition characterized by the growth of horny excrescences.

Ceratichthyosis. (L.) Ichthyosis of the cornea.

Ceratitis. Another spelling of keratitis. A plant much used by the ancients in diseases of the eyes. See **Celandine.**

Ceratocele. (L.) KERATOCELE; tumor, swelling or bulging of the cornea.

Ceratocentesis. (L.) KERATOCENTESIS. Paracentesis of the cornea.

Ceratoconus. (L.) KERATOCONUS. Conical cornea.

Ceratodeitis. (L.) Obsolete form for keratitis.

Ceratodeocele. (L.) Old form of keratocele.

Ceratodeonyxis. (L.) Obsolete form of keratonyxis (q. v.).

Ceratodistos. (L.) The corneal tissue.

Ceratoditis. (L.) See **Keratitis.**

Ceratoglobus. (L.) Obsolete writing of keratoglobus.

Cératoïde. (F.) Keratoid.

Cerato-iritis. (L.) See **Kerato-iritis.**

Ceratoleucoma. (L.) Leucoma of the cornea.

Ceratoma. (L.) Tumor of the cornea.

Ceratomalacia. (L.) Keratomalacia, or sloughing of the cornea.

Ceratome. An instrument for cutting the cornea; a keratome.

Ceratomeningitis. (L.) An obsolete form of keratitis.

Ceratomeninx. (L.) (Obs.) The cornea.

Ceratometaphyteia. (Obs.) Transplantation of the cornea.

Ceratometathesis. (Obsolete.) Transplantation of the cornea.

Ceratomia. (L.) The corneal incision of a cataract operation.

Ceratonosus. Another form of keratonosis. Any one of a class of skin-diseases characterized by thickened epidermis, and the presence of such callosities as horns, warts, etc.

Cérat ophthalmique. (F.) An ointment made of 18 parts of ceratum Galeni and 1 part, each, of powdered red percipitate and pulverized camphor. Formerly prescribed in "cases of moderately acute ophthalmia."

Ceratophthalmus. (L.) In *zoology,* having the eyes inserted in the end of horn-like projections.

Ceratoplasty. Keratoplasty.

Ceratoscope. An instrument with which the cornea is examined. A keratoscope.

Ceratoscopy. Keratoscopy, or the shadow test of refraction.

Ceratotome. Same as *ceratome.* An instrument for cutting the cornea; a keratome.

Ceratotomy. Incision into the cornea for extracting a cataract or for forming an artificial pupil; keratotomy.

Ceratum Galeni. A cerate made of 5 parts of simple cerate mixed with 2 of expressed oil of sweet almonds and 3 of rosewater. See **Cold cream.**

Cerchio arterioso sclerale di Zinn. (It.) Scleral (vascular) circle of Zinn.

Cercine lenticolare di Soemmering. (It.) Soemmering's crystalline swelling.

Cercle. (F.) Circle; ring.

Cercle artériel de Haller. (F.) Haller's circulus arteriosus.

Cercle ciliaire. (F.) Ciliary ligament.

Cercles de dispersion. (F.) Circles of dispersion.

Cercle veineux de l'iris. (F.) Venous circulus iridis.

Cerebellum, Tumors of. These neoplasms produce, as a rule, *intense choked disk* with marked edema of the surrounding retina, and often a stellate figure in the macular region. The same conditions have, however, been observed in basal meningitis, and in tumor of the frontal lobe. Nystagmus on turning the eyes toward the side of the lesion has also been observed by Spiller and others.

C. A. Veasey speaking of the *symptoms* of a case of cerebello-pontine tumor diagnosed and located three years before death says (*Ophthal. Record,* March, 1913) that there were first noticed the evidences of compression or of intracranial tumor, viz., choked discs, intense occipital headache, nausea, vomiting, vertigo and ataxia; and as symptoms of localization the lack of function of the right auditory nerve, early development of noises in the right ear, diminution, then failure of hearing on the right side, together with dizziness and vertigo. In addition there were involvement of the right facial nerve, the right sixth nerve, and the right fifth nerve, all on the right side. A diagnosis was therefore made of a tumor in the right cerebello-pontine angle.

Parkinson and Hosford (*Ophthal. Review,* May, 1908) report a case of cerebellar tumor associated with that rare symptom—proptosis. The symptoms were convulsions, dimness of sight (other senses normal), severe headache, nuchal muscles contracted. There were no knee-jerks, nor was Kernig's, or Babinsky's sign, or ankle clonus to be obtained. Sensation was normal, memory good, and hearing, smelling, taste and speech were natural. Patient was inclined to be emotional at times. The right arm was decidedly weak, both in the grip of the hand and the forearm muscles, and of this she complained.

The condition of the eyes was as follows: Great proptosis of each eye, equal on the two sides, so that much of the sclerotic was visible, and the eyelids correspondingly stretched. The lids and conjunctivæ were otherwise natural. There was no edema, congestion, or chemosis, and the corneæ were natural. There was well-marked paresis of the right external rectus muscle and the centre of the cornea could never be brought to the mesial line. The left external rectus was weak but not nearly so markedly as the right. There was slight but definite horizontal nystagmus, which disappeared on admission but re-appeared the day before death. Altitudinal motions were normal. Von Graefe's and Stellwag's signs were absent, but Dalrymple's sign (widening of the palpebral fissure) was present. The pupils were equally dilated to 8 mm., and reacted very faintly and slowly to light. The tension was normal and the media were clear. There was in each eye, but more marked in the right, the most *intense choked disc* (neuro-retinitis, right=4 mm., left=3 mm.) accompanied by hemorrhages, some of which were becoming decolourized. In the macula of the right eye there was a somewhat stellate whitish mass of exudation. Vision was reduced to counting fingers.

The patient died suddenly and at the autopsy it was found that the proptosis persisted although the eyeballs could be pressed back into place. Convergence of each eye. No sign of separation of the cerebral sutures, or alteration in bony orbit.

On opening cranium the meninges were natural, but there was an escape of a great quantity of intra-ventricular clear fluid. The ventricles were much dilated, and the cerebral cortex flattened and thinned and tunics of nerve sheath distended. The orbit was natural. Attached to the pia mater on the under surface of the right lobe of the cerebellum was an irregular, flattened, well circumscribed, encapsulated, very firm, pink growth, about the size of a large pigeon's egg, and containing old blood clot in the centre. It pressed upon the restiform body and medulla oblongata on the right side, dipping down so much into the foramen magnum that a piece of the tumour was left behind by the pathologist during the process of removing the brain.

The whole growth appeared to have been wedged between the bony wall and the right side of the medulla.

Microscopical examination showed the growth to be a fibro-psammoma. There was a small *post-mortem* clot in the right lateral sinus far back. The other organs in the body were natural. See. also, **Choked disk** and **Brain tumor.**

Cerebral abscess. According to Parsons (*Pathology of the Eye,* p. 1357) of 200 cases of choked disk Kampherstein reported brain abscess in 7 (3½ per cent.), mostly due to middle-ear disease. Knapp found abscess of the temporal lobe to be the commonest—66 per cent. Parsons observed a case of bilateral papilledema in right orbital cellulitis with abscess of the right temporal lobe. The comparative rarity of choked disc in brain abscess is attributed by Deutschmann to the thick capsule which prevents the distribution of phlogogenic material. Gowers considers the probability dependent upon the rapidity of onset. Kampherstein has collected 155 cases of brain abscess, and found optic neuritis in 37, hyperemia in 4, atrophy in 1, retinal hemorrhage in 1, papilledema in 42, no ophthalmoscopic note in 70. Papilledema occurs therefore in 25—30 per cent. of all cases. Cases of recurrence of papilledema after operation, due to proliferation of granulation tissue, are reported by Jackson, Benedickt, Pflüger, Hadden, Norton, Murray, Gowers, Knapp, and others. Unilateral papillitis (6 times) and papilledema (twice) occur occasionally. See **Neurology of the eye**; and **Choked disk.**

Cerebral aneurysm, Ocular relations of. There are very few eye signs or symptoms that can be relied upon for the diagnosis of aneurysm of the cerebral artery. Papilledema is quite unusual and, according to Beadles, only an autopsy will establish the presence of the vascular disease. Parsons remarks that in the case reported by Holmes "There was a growth of the pituitary body as well as aneurysm of the internal carotid. There was papilledema in the cases of large aneurysm reported by Anderson and Bramwell. Waldo's case, an aneurysm of the size of a cherry on the right internal carotid, had bilateral papilledema. Hutchinson, in a case of aneurysm of the basilar artery, found hemorrhages of the retina. Hemorrhage into the optic nerve sheath is recorded by Bramwell, Mott and Hale White." See, also, **Aneurysm of the cavernous sinus; Aneurysm of the internal carotid.**

Cerebral apoplexy. See **General diseases.**

Cerebral apoplexy, Treatment of. See **General diseases.**

Cerebral centres for vision. See **Neurology of the eye**; and **Centres, Visual.**

Cerebral cortex reflex of pupil. This reaction, which has as yet no clinical significance, is known by the name of its discoverer, Haab, who describes it as follows: If in a room illuminated only by a lamp or candle-flame, the light is placed so that it will shine laterally into a person's eyes while they look directly forward into the darkness, a marked contraction of both pupils takes place whenever the attention is directed toward the light, with no change in the position of the eyes. As long as the attention is directed to the light and fixation of the eyes on the dark wall is maintained the pupils remain contracted, but as soon as the attention is transferred to the point of fixation they dilate, although the quantity of light entering the eye has remained constant and all movements of accommodation and convergence are excluded.

Cerebral decompression. The operation for craniectomy and cerebral decompression has been discussed and described under **Choked disk,** as well as under the heading **Brain tumor, Operations for.** It may be repeated here that, as de Schweinitz says, it is indicated not only in those cases where brain tumor can be successfully removed but also in inoperable cases, "A palliative operation, that is, *cerebral decompression,* should be performed in order to save sight, and the earlier it is done the better the results will be—i. e., operation should be undertaken before the third stage of the disc change is reached. Usually, after technically correct operations (and in all pretentorial tumors decompression is the operation of choice, and in all subtentorial lesions a suboccipital decompression is indicated [C. H. Frazier]), the choked disc begins to subside from the third to the tenth day, and the subsidence is complete at the end of six weeks. The same operation is urged by Cushing in the choked disc caused by cerebral edema, infectious and intracranial hemorrhage. Choked disc has also been treated by lumbar puncture, but with this procedure for this purpose the author has had no experience. His results with cerebral decompression have been most gratifying."

Cerebral degeneration, with macular changes. According to Parsons (*Pathology of the Eye,* p. 1372), instances of this disease constitute a distinct group. The first case was reported by Rayner Batten, in which pigmentary changes at the macula, pallor of the disc, and contraction of the retinal vessels is associated with more or less pronounced idiocy. In most cases there is a history of syphilis in the parents but no signs of congenital syphilis in the children; in some there is consanguinity in the parents. The ocular condition and the mental deterioration arise at about the same period of life—from 7 to 14 years of age. The macula generally shows a reddish-black spot surrounded by an area of coarsely-granular pigmentation.

Cerebrale Augenstörungen. (G.) Ocular disturbances of cerebral origin.

Cerebral embolism. See **General diseases.**

Cerebral hemispheres, Ocular relations of the. See **Neurology of the eye.**

Cerebral hemorrhage. Involvement of the ocular apparatus in ordinary cases of cerebral hemorrhage is not common. However, A. Pichler (*Zeitschr. f. Augenheilk.*, 1913, p. 36) has observed rhythmic protrusion of both eyeballs through action of the trochlearis—a particular condition which he has called *nystagmus protractorius.* He noticed that during the period of unconsciousness between the apoplectic seizure and the death of the patient, the following ocular conditions were observed: Oscillatory nystagmus in the vertical meridian, slight adduction, deviation downward and a pulsatory protrusion of both eyes synchronous with inspiration. The eyes were turned slightly down at each protrusion. Autopsy showed extensive hemorrhage into the third, fourth and lateral ventricles and numerous small hemorrhages into the pons. The movements of the eyes are attributed to contraction of the superior oblique muscle due to central irritation of the trochlear nerve. On this account and because of the rhythmic character of the movements, probably in some way connected with the variation in intracranial pressure occurring with each deep inspiration.

Cerebral hernia, Ocular relations of. The ocular involvement in hernia of the brain substance is not very definite. However, in most instances there is eventually an optic neuritis of the choked disk type. Such a case, for instance, is reported by J. H. Lloyd (*Jour. Nerv. and Ment. Dis.,* 28, May, 1911). In this case there was marked improvement in optic neuritis after a decompression operation.

Cerebral layer of the retina. This retinal layer of nerve-fibres consists of non-medullated axis-cylinders arranged in bundles. They are most numerous at the site of entrance of the optic nerve, and run radially to the ora serrata. For the most part they are centripetal fibres derived from the ganglionic layer, but there are also centrifugal fibres coming from cerebral ganglionic cells, which end free in this layer.—(J. M. B.)

Cerebral relations of the visual apparatus. See **Neurology of the eye.**

Cerebral tumor. See **Brain tumor** and **Choked disk.**

Cerebral tumors, Eye symptoms of. See **Brain tumor, Eye symptoms of.**

Cerebral tumors, Removal of. See page 1276, Vol. II, of this *Encyclopedia,* under the section **Brain tumor, Operations for.**

Cerebral ventricles, and their ocular relations. See **Neurology of the eye.**

Cerebral vesicles. See **Embryology of the eye.**

Cerebritis, Ocular symptoms of. The various forms of inflammation or infection of the brain substance give rise occasionally to optic neuritis, although the proportion of cases in which eye symptoms appear is comparatively small.

Cerebroscopy. Bouchut's term for ophthalmoscopy, employed by neurologists for the diagnosis of brain diseases.

Cerebrospinal meningitis, Eye symptoms of. LEPTOMENINGITIS. ACUTE CEREBRAL MENINGITIS. Especially in the epidemic form of this fatal disease of infantile life, particular neuro-ophthalmological changes are common. As Hecht (Wood's *System of Ophth. Therapeutics,* p. 293) says, when one meets with any form of septic meningitis due to an invasion of the pia by a streptococcus or staphylococcus, the endemic form seen in infants, the tuberculous and syphilitic types or, finally, the epidemic cerebro-spinal meningitis caused by the diplococcus intracellularis of Weichselbaum, we are impressed with the fact that in all forms the pathological process may be sufficiently extensive to implicate the entire convexity of the brain and more commonly the base, inclusive of all the cranial nerves. That being the case, it is not strange that ocular manifestations are at some time conspicuously present in one or all of the varieties of meningitis. In the septic forms the convex pia is a favorite site; in the meningitis of infants the base is more often involved; the tuberculous variety is preponderatingly basilar; likewise the syphilitic type, in which a degenerative neuritis is present involving the more anterior of the cranial nerves at the base, especially the optic and oculomotor. In the epidemic form the pia of both brain and cord is affected.

Consistent with this localization, neuro-ophthalmologic observers assert the possibility in meningitis of (1) pupillary inequalities and irregularities; (2) iridoplegia; (3) strabismus; (4) nystagmus; (5) optic neuritis and atrophy; (6) exophthalmos; (7) hippus; (8) ocular paralyses; (9) keratitis.

Cosmettatos (*Annales d'Oculistique,* October, 1908) reports a case of this affection. According to Uhthoff, metastatic ophthalmia occurs in four or five per cent. of all cases of cerebro-spinal meningitis. It is usually unilateral, but occasionally both eyes are simultaneously affected.

It is generally considered that the purulent metastasis commences nearly always in the retina or choroid and the uveal tract. Generally there is purulent retinitis with propagation of inflammation to the vitreous and iris. Lesions of the optic nerve or of its sheaths have not often been found.

Meningococci have been found in the blood of patients affected with the metastatic ophthalmia, which tends to show that the metastasis is accomplished through the circulation. They have also been discovered in the interior of the eye, but only in the commencement of the disease and have disappeared when the vitreous has been examined a little later, which shows that the metastatic ophthalmia is produced by toxins.

McKee (*The Ophthalmic Record,* September, 1908) saw seven cases of epidemic cerebrospinal meningitis in which ocular complications were present. One was a case of metastatic ophthalmia and six were cases of conjunctivitis. From the pus in the anterior chamber of the hypopion iritis case and from the conjunctiva in two cases of conjunctivitis were cultivated Gram negative diplococci, which were carefully studied and shown to be meningococci. To these cases is to be added the cultivation of the meningococcus once from the normal conjunctival sac. The author lays great stress upon the inaccuracy of basing a diagnosis of the meningococcus upon the presence in smear preparations of Gram negative diplococci. Meningococci can only be positively demonstrated by carefully studying them in cultures on various media.

The *treatment* of the eye symptoms is of course involved in the conduct of the cerebrospinal disease with which they are so intimately associated. As Hecht *(loco cit.)* intimates, *prophylaxis* in this disease means the quarantine of an already existing case and careful disinfection of all things brought into contact with the patient, thus limiting the transfer and spread of the contagion. An examination of the nasopharynx and tonsils of those exposed to the disease, including the bacteriologic findings, is also indicated. A good general and better local resistance to infection goes far toward protecting the individual.

Lumbar puncture has been advocated in meningitis by some for its curative effect and by others for its positive palliative value. It certainly occupies a place of increasing importance in the diagnosis of many nerve lesions, and its rôle in the modern serum treatment of cerebrospinal meningitis in particular justifies, it is believed, an extended reference to it as a therapeutic measure.

The claim made in behalf of its specific action is based upon the results following (1) withdrawal of numerous bacteria; (2) removal of pus; (3) reduction of intracranial pressure; (4) diminution in the toxicity of the spinal fluid. Its success as a palliative is estimated by the early and prompt relief of the patient from intense headache, delirium, convulsive seizures, fever and even the coma, resulting in a marked general improvement.

The fearful mortality of cerebrospinal meningitis has undergone great reduction since the advent of the Flexner serum, and although it is much too recent for the last word to have been spoken concerning its exact position in the therapeutics of this disease, quite enough clinical data are at hand to indicate that in this serum we have a most potential remedy.

The technic of administration is simple and consists of a lumbar puncture done with intent to draw off, if possible, 30 c. c. of cerebrospinal fluid, and allowing an equal volume (30 c. c.) of serum to run into the spinal canal, through the puncture needle, which has not been disturbed. Similar to the first practices in giving diphtheria antitoxin, this serum is poured from a bottle into a large-sized syringe, which is then attached to the needle, already in place, and under some pressure made upon the piston (if that be necessary), the fluid enters the canal. It is not always possible to withdraw the requisite amount (30 c. c.), of fluid, and in some instances none may escape, in which event 10 to 20 c. c. of serum may nevertheless be introduced, without giving rise to undesirable pressure symptoms. Flexner suggests, that before using, the serum be heated to body temperature by immersing its container in warm water. Thirty cubic centimeters constitutes the average dose for a single injection, to be repeated three or four times, at intervals of from twenty-four to forty-eight hours, depending upon the rate of improvement.

An analysis of some 400 serum-treated cases, tabulated by Flexner himself (Flexner and Jobling, *J. A. M. A.*, July 25, 1908), confirms the good report of an earlier series, viz., 75 per cent. recoveries and 25 per cent. deaths. From the literature to date, it is to be inferred that Flexner's anti-serum (1) has greatly reduced the mortality in epidemic cerebrospinal meningitis from a seventy or eighty per cent. to a twenty-five per cent. death rate. (2) It can and should be used at the earliest possible period in the disease. (3) It greatly changes the clinical complexion and course of the individual case, lowering temperature by lysis or crisis, relieving symptoms and lessening the liability to sequelæ. (4) It should be repeated so long as symptoms remain. (5) In some cases, especially the chronic ones, it seems to have little or no good effect.

The patient, on account of the unusual degree of cerebral irritability, should lie in a room with very subdued light and removed from all sources of intrusion and noise. The head should rest in elevation on an ice-bag placed at the nape of the neck and spine, and an ice-cap be applied to the head. When the temperature continues to exceed 103° F., cool sponges or baths are indicated. When temperature is not so high and the restlessness is extreme, the prolonged warm bath (90° to 100° F.) given every three or four hours for a half-hour at a time has a marked sedative effect, but the utmost care must be exercised in the matter of lifting and moving the patient. Too active purgation, as formerly practised, has been discarded in favor of a mild catharsis. In vomiting of the cerebral type the remedies used in acute gastritis are unavailing and bromides in large doses per rectum are most serviceable. The intense cephalalgia, restlessness and convulsions as well as delirium are best controlled by small and repeated hypodermics of morphine, gr. 1-12 to ¼, although great benefit has been derived from the use of small doses of veronal (grs. ii to iii), given every three or four hours for days at a time.

Resorbents, either in salve or plaster form, are recommended by a few, but all, with the possible exception of unguentum Credé, are valueless in this particular form of meningitis.

Since the soluble silver preparations have been regarded as effective in the septic and septicopyemic conditions occurring in children, they have been given a trial in meningitis, and are looked upon with favor. The unguentum Credé in the amount of ʒi to ℥ss, rubbed into the skin of infants and children once daily, and oftener, if indicated, is said to be absorbed in sufficient amount to allow of a favorable action from the silver therein contained. In adults it is less readily absorbed, and another colloidal silver preparation, collargolum, given by mouth, per rectum or intravenously, may be substituted, and is said to give good results. It is put into a vein in the amount of three to five c. c. of a 1 to 5 per cent. solution, and when given rectally, five to seven grains are dissolved in water.

Counter-irritants, once popular, are no longer used.

A supportive treatment by food and alcoholic stimulation is of the utmost importance. Nourishment should be given by nutrient enemata or nasal feeding, and brandy or champagne, given often and in adequate doses, relied upon to combat the toxemia.

During recovery moderate doses of iodide are thought to do good.

As for special eye symptoms relating to the optic nerve, choroid or retina, they are likely to terminate in blindness, but their treatment, together with that of keratitis, must be conducted along regular ophthalmological lines.

Surgical intervention is not called for in so diffuse a disease process, but Macewen reports six cases of cerebrospinal meningitis operated upon, with one recovery.

Cerectomy. Corneal incision.

Céréléon. (F.) A mixture of wax and oil for dressing.

Ceresin. A hard, white paraffin prepared from ozokerite or earth wax.

It has a melting point of about 130° F. It enters, like most other paraffins, into various eye ointments. See, also, **Paraffin.**

Cerevisine. YEAST. BREWER'S YEAST. A viscid liquid or soft mass consisting of the cells and spores of saccharomyces cerevisiæ. It is supposed to have an antiseptic action due to the enzymes, especially zymase and invertase, present.

Webster Fox (Text-book, p. 555) advises the use as a germicide in gonorrheal ophthalmia of cerevisine in 25 per cent. solution. It is to be instilled into the eye 4 times daily. Dried yeast is also used internally for furunculosis of the eyelids in doses of 1 teaspoonful before each meal.

Cerintha major. (L.) Wax-plant. Used in ophthalmic affections.

Cerise. (F.) Cherry.

Cerne. (F.) A bluish discoloration around the eye, especially beneath the lower lid.

Céroïde. (F.) Resembling wax.

Certamen. A scientific meeting restricted to the persons invited.

Cérulescent. (F.) Bluish.

Céruse. (F.) White lead.

Cerveau. (F.) Cerebrum; brain.

Cerveau, Abcès du. (F.) Cerebral abscess.

Cervelet. (F.) Cerebellum.

Cervelet, Maladie du. (F.) Disease of the cerebellum.

Cervelle. (F.) Brain.

Cervello, Malattie del. (It.) Diseases of the cerebellum.

Cervical ganglion, Excision of the superior. Posey (*Wood's System of Ophthalmic Operations,* p. 1130) has fully dealt with this subject. He points out that, as de Schweinitz relates, so long ago as the time of Pourfour de Petit, that is, in 1727, it was observed that after section of the sympathetic, the eye was softer, and this fact was afterwards verified by Claude Bernard and other experimenters, and very early it was suggested that a primary disease of the sympathetic ganglia of the neck might be the basal cause of glaucoma.

The various theories which had been advanced by different observers to explain the influence of the sympathetic on intraocular tension were then discussed at length and the conclusions from the evidence which had been collected summarized as follows: "Electrical stimulation of the cervical sympathetic produces at first an increase and later a decrease of intraocular tension, the increase being probably due to an effect on the muscles of the eye. Slow-acting, mechanically produced irritation of the sympathetic causes a rise of tension, which, according to Lodato, is independent of dilatation or constriction of the blood vessels, and also independent of the state of the pupil. Section of the sympathetic, or extirpation of the sympathetic ganglion, is followed by a fall of intraocular tension, which depends on vascular and, perhaps, muscular changes. The lowering of tension is more decided after excision of the ganglion than after section of the sympathetic cord, but, in either case, the effect is a temporary one, and may last more than a few days, and sometimes disappears within a few hours.''

According to Grimsdale and Brewerton, Wegner noticed changes of the intraocular pressure in animals when the cut end of the cervical sympathetic was stimulated, a fact noted in the 12th volume of Graefe's *Archives*. It was not, however, until 1897 that any form of operation was proposed on the vaso-motor nerves of the eye to influence glaucoma, when Abadie, who ascribed the increased tension of glaucoma to a vascular disturbance, proposed to relieve the condition by the removal of the cervical sympathetic. Before he had an opportunity, Jonnesco published a paper in which he reported the results of a series of operations which had been performed in pursuance of Abadie's suggestions. Both of these investigators, however, held different theories as to the cause of glaucoma, Abadie attributing it directly to an increase of exudation brought about by an active dilatation of the blood vessels, particularly the arteries, while Jonnesco asserted that the small arteries are contracted, and that the resulting increase of intra-vascular pressure occasions an increased transudation and probably an increase in the amount of aqueous humor. The dilatation of the blood vessels was thought by Abadie to be due to the activity of the vasomotor centres and he asserted that, when the chain is cut, the stimuli cease, and the blood vessels resume their normal caliber.

Jonnesco removes the superior cervical ganglion by an incision along the anterior border of the sterno-mastoid muscle, about 3 inches long, having its center opposite the angle of the jaw. The various layers of the cervical fascia are then carefully divided until the border of the muscle is exposed. The sheath of the carotid artery is then laid bare and the dissection continued between the artery and vein until the ganglion is exposed behind the former.

To avoid the risk of opening the sheath, Burghard deflects it inwards with a blunt hook, when the sympathetic ganglion is found just posteriorly. The ganglion is readily freed from its surroundings by careful dissection, and is excised by a few clips of the scissors, the ascending branches being divided close about the top, and the descending cord about half an inch below the ganglion. The wound is then sutured. Some operators advise exposing the ganglion by way of the posterior portion of the sterno-cleido-mastoid muscle, but, as this exposes the spinal accessory nerve to the risk of injury, the anterior route is to be preferred.

In the symposium referred to above, Wilder spoke of the influence of resection of the cervical sympathetic ganglion in glaucoma and epitomized the records of 68 operations done on 54 cases in the following table:

SUMMARY

Form of Glaucoma.	No. of Cases.	Improved.	Temporarily Improved.	Stationary.	Unimproved.
Simple chronic	38	15	5	3	15
Chronic inflammatory	16	4	3	3	6
Subacute	4	3	1	..	..
Acute	3	1	1	1	..
Absolute	4	1	..	..	3
Hemorrhagic	2	2	..	..	..
Buphthalmus	1	..	..	..	1
	68	26	10	7	26

The results exhibited in this series of cases, at first glance, do not seem as favorable as those presented by Rohmer who drew conclusions from a study of 74 cases collected by Richat, to which he added 20 of his own. On these 94 cases, 114 operations were done. The following table gives a summary of the results of their analysis of these cases:

Form of Glaucoma.	No. of Cases Operated on.	Improved.	Negative.	Worse.
Simple chronic	43	36	5	2
Chronic inflammatory	34	23	10	1
Subacute	14	6	6	2
Acute	9	4	5	..
Absolute	3	1	2	..
Hemorrhagic	5	5	..	..
Hydrophthalmus	6	4	1	1
	114	79	29	6

As a consequence of the statistics which he had gathered, Wilder thought that while positive conclusions are yet to be reached and will not be attained until more carefully selected cases can be studied for longer periods of time, he could assent to the statement of Axenfeld that "there is obtained by this operation in a certain proportion of cases of simple glaucoma, a definite and important result, and in some instances there has been a decided improvement, even where a previous iridectomy has failed."

Wilder considered the operation in itself, while a major one, is not to be regarded as one of unusual danger, and with modern technique should show a very trifling mortality. His conclusions were as follows: "The statistics up to date seem to indicate that the simple chronic form is the one most suited for it, next to the hemorrhagic form, if that can be determined. As a guide for my own practice, I should feel very much like following Abadie when he says: 'In acute forms of glaucoma and in subacute with intermissions, practise first iridectomy, and if it fails, do sympathectomy. In simple glaucoma, use miotics twice a day; if they suffice, continue them. If, in spite of their systematic employment, the vision fails, do sympathectomy.' "

During the past few years, the operation has been rarely practised, for, though sometimes successful in reducing tension, disastrous results have also occurred, and several have died from the operation. In others symptoms of tachycardia and exophthalmus have developed. Its most favorable results are no better than can be attained by other and less dangerous operations on the globe itself, or from the continuous use of miotics.—(W. C. P.)

Cervical sympathetic and its ganglia. A most important ophthalmic function of this nerve is its innervation of the *dilatator pupillæ.* It is also of importance to the ophthalmologist, since all sympathetic fibres passing to the orbit traverse the superior cervical ganglion, except possibly those which follow the course of the fifth nerve. The cervical portion of the nerve consists of three ganglia and the intervening strands. The *superior cervical ganglion,* the largest of the three, is a fusiform body about an inch in length, and is placed in front of, and internal to, the transverse processes of the second and third vertebræ. It gives branches to the anterior divisions of the first four cervical nerves, to the hypoglossal, one to each of the ganglia of the vagus, one to the petrous ganglion of the glosso-pharyngeal, several to the carotid arteries, the pharynx, several cardiac branches, and branches to the small deep petrosal nerve, the cavernous plexus, the third and fourth nerves, and the ophthalmic division of the fifth. The sympathetic root of the lenticular ganglion passes into the orbit either separately or in conjunction with the nasal branch of the fifth nerve.

The *middle sympathetic ganglion,* placed opposite the sixth cervical vertebra, is smaller than the superior, and is sometimes absent. It gives communicating branches to the fifth and sixth cervical nerves, vascular branches to the inferior thyroid artery and thyroid gland, and a middle cardiac branch.

The *inferior cervical ganglion* lies on the neck of the first rib. It gives branches to the seventh and eighth cervical nerves, to the vertebral artery, and to the deep cardiac plexus.—(J. M. B.)

Cervix. (F.) The neck (*not* the cervix uteri).

Ceylon moss. JAFFNA MOSS. A dried sea-weed resembling isinglass, first introduced into commerce from the East Indies in the shape of colorless, transparent strips. It is almost entirely soluble in water, when it swells and forms a quantity of thick jelly. The moss is an article of food in the East, and is employed in the laboratory as a culture medium.

Chactas. An old blind North American savage, the hero of Chateaubriand's *"Atala."* His name means "The harmonious voice." In the words of Chateaubriand's introduction to his story: "A young girl used to accompany him on the hills of the Mississippi, just as Antigone formerly guided the steps of Œdipus over the Cithaeron, or as Malvina conducted Ossian over the rocks of Morven." To a French adventurer by the name of René, who reached the territory of the Natchez in 1725, and who was made a warrior of that nation, the blind old patriarch related the story of his adventures. This story is, in fact, *"Atala."*—(T. H. S.)

Chadwick, George Henry. Born July 13, 1831; received his medical degree at the Albany Medical College; practiced at Portland, Me., and died in the same city, Feb. 25, 1888. He never wholly gave up general practice, but was widely known as an ophthalmologist, especially because of his invention of "Chadwick's Pterygium Scissors." These were based upon the idea that scissors for the removal of pterygium should be constructed to fit exactly the curvature of the eyeball.

He was a short, heavily built man, of swarthy complexion and jet black hair; of a slouchy gait and retiring disposition. He was a hard student, and was very much liked by his confrères.—(T. H. S.)

Chainette, Scie à-. (F.) Chain saw.

Chair de poule. (F.) Goose-flesh; cutis anserina.

Chaise-lit. (F.) Chair-bedstead.

Chalasie. (F.) Partial separation of the cornea from the sclerotic.

Chalasis. (L.) (Obsolete.) This term was employed by Wenzel to describe the detachment of a portion of the cornea from the sclerotic; by Helling, to indicate the encroachment of the iris upon the pupil.

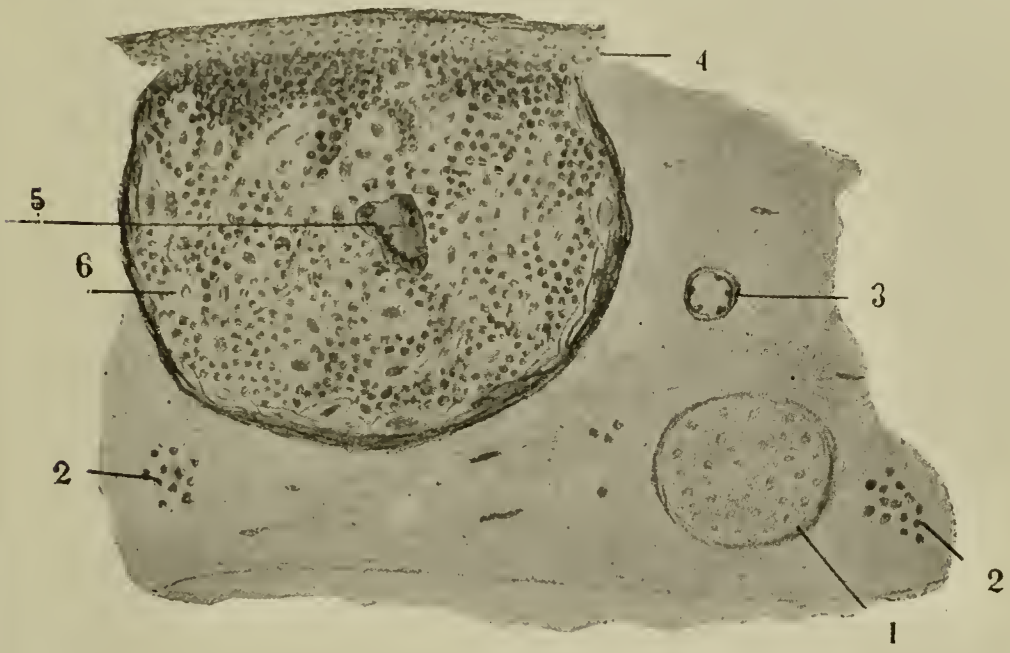
Chalasmus. (L.) A synonym of **Chalasis.**

Chalazacium. (L.) Chalazion.

Chalazia. (L.) A chalazion.

Chalazicgus fungus. A micro-parasite.

Chalazion. MEIBOMIAN CYST. HAILSTONE. TARSAL TUMOR. BLIND STYE. GRANULOMA GIGANTO-CELLULARE (de Vincentiis). A very common, small tumor in the substance of the tarsus, formerly regarded as a retention cyst, or as a non-suppurating hordeolum, the result of obstruction in the excretory duct of one or more Meibomian glands.



Microscopic Section of a Chalazion. (Ball.)
(Original drawing by Dr. Carl Fisch.)
1, Meibomian gland cut across. 2, 2, Areas of round-cell infiltration. 3, Artery. 4, Conjunctival epithelium. 5, Giant cell. 6, Epithelioid cell.

A chalazion forms a round, hard, small tumor situated commonly in the middle of the lid near its border. It is more frequent in the upper than in the lower lid, and is more often found in adults than in children. Its progress may be in the direction of the conjunctiva (internal chalazion) or toward the skin (external chalazion). When the lid is everted the conjunctiva over the chalazion is found to be red and thickened, and in advanced cases a bluish or grayish spot is seen corresponding to the thinned tarsus. Several chalazia may be present at the same period or single tumors may develop from time to time. As a rule, chalazion is painless, and causes inconvenience only when it attains a considerable size, in which case the eyelid may droop and the tumor will cause a deformity [and astigmatism]. Not infrequently chalazia disappear spontaneously. When perforating the conjunctiva, the chalazion leaves granulations and thus may simulate a malignant growth. The growth of a chalazion, while generally slow, may be rapid. Acute chalazion may develop rapidly, with pain, swelling, and localized conjunctivitis. The growth may undergo suppuration, in which case it resembles a stye.—(J. M. B.)

Parsons (*Pathology of the Eye*, p. 10) regards tarsal tumor as a *granuloma* or a chronic inflammatory affection of a Meibomian gland, in which the granulation tissue contains giant cells—as Fuchs pointed out. "The epithelium of the acinus first proliferates without forming fatty sebaceous material, so that the cytoplasm stains well. The acinus becomes swollen and forms club-shaped expansions. The central fatty cells are imprisoned, and break down in granular amorphous flakes. The surrounding tissue of the tarsus in densely infiltrated with lymphocytes, and the fixed cells proliferate. This process soon becomes the predominant one, so that both the acini of the gland and the periacinous tissue are ultimately lost in a mass of granulation tissue. This contains giant-cells, which are said to be derived both from the glandular epithelium and from the endothelium of the periacinous tissue. According to Krause, the surrounding infiltration is the primary phase. According to Fuchs, the glandular changes are primary, and he compares it to a desquamative catarrh following prolonged or repeated inflammation of the conjunctiva or lid-margin. The inflammatory process either extends up the ducts of the glands, or leads to obliteration of their mouths. The growing tumor presses more and more upon the surrounding tissue, which becomes compressed, and forms a connective-tissue capsule. This is least developed in the direction of least resistance, which is usually towards the conjunctival surface, and here the granulation tissue extends, and finally breaks through. The chalazion is poor in vessels, proliferation taking place chiefly at the periphery. The centre contains remnants of glandular tissue, infiltrated with cells, lying in fibrous tissue which has few cells. The fibrous development probably leads to retrogressive changes in the blood-vessels, and the central parts degenerate. The fibres become hyaline and fuse into a fluid homogeneous mass; the cells become vacuolated and finally disappear. The tissue does not give the reactions of mucin, and is therefore not a true myxomatous degeneration. The giant-cells also degenerate, so that they are more numerous in the early than in the later stages. In old chalazia the entire contents may be liquefied and may form a cyst, with a thick fibrous wall, containing turbid gelatinous fluid.

At a time when the Langhans type of giant-cell—with the nuclei arranged around the periphery or at the poles—was regarded as pathognomonic of tubercle, chalazion was naturally included in this category. It is now known that the ordinary irritation, or foreign-body giant-cell (Fremdkörperriesenzell), may be of the Langhans type. Moreover material from chalazia inoculated into the anterior chamber of rabbits does not produce tuberculosis (Weiss, Deutschmann, Landwehr, etc.), though when placed in the peritoneal cavity of guinea-pigs it may cause death (Parisotti). v. Wichert considered twenty-eight out of thirty-two chalazia tuberculous on anatomical grounds, though bacilli were only found twice, and inoculations failed. At the same time it seems probable that exceptionally chronic tuberculosis of the tarsus may show the clinical picture of chalazion (v. Michel, Tangl, and v. Wichert), and ordinary chalazion in tuberculous subjects may contain tubercle bacilli (Tangl). Inoculation of dead tubercle bacilli will not produce the complaint (Deyl). Palermo produced tubercle of the tarsus by inoculation in rabbits, but it led to ulceration and even death, but no evidence of chalazion. He regards the condition as a foreign-body granuloma, in which chemical, physical, or bacterial irritation may play a part, leading to a desquamative catarrh, with adenitis and periadenitis. Specific organisms have been described. Poncet and Boucheron confirmed by Lagrange, found cocci which stained by Gram; they were of unequal size, and were possibly nuclear fragments (Uhthoff and Axenfeld). Deyl found bacilli invariably in fresh chalazia (chalazion bacilli). He admits their morphological and cultural identity with xerosis bacilli. Hála found them in large numbers in young chalazia only. They gradually dwindle, so that in four or five weeks they are absent. They are short thick rods with rounded ends, one usually thicker than the other; in the later stages they are larger, and show more segmentation. In common with Uhthoff and Axenfeld and others, he regards them as xerosis bacilli. Priouzeau found staphylococci, diplobacilli, Friedländer's pneumobacilli, streptococci, tetragenus, leptothrix; he considers staphylococci causal. He is strongly in favor of the infectious nature and transmissibility of the disease, both on insufficient grounds.

Beatson Hird has abstracted (*Oph. Review,* July, 1910, p. 215) the paper of Buri (*Beiträge zur Augenheilk.,* Dec., 1909) who discusses the pathology of chalazion. He premises the discussion by reminding us that authorities formerly regarded the growth as due to disease of the hair follicles, and others that it was a retention cyst. Later it came to be regarded as a granuloma arising from the Meibomian gland and was relegated to the category of scrofulous inflammations. Deutschmann in 1891 settled the question with regard to chalazion being tubercular. He could find no evidence whatever of this. He agreed with de Vincentiis and Fuchs that it was a chronic inflammation of the Meibomian gland with proliferation of the gland epithelium and a consecutive chronic infiltration of the surrounding connective issue, a chronic adenitis and periadenitis of the Meibomian gland. More recently the matter has been gone into by French investigators.

Lagrange (1904) pointed out that the chief mass of the chalazion developed in the connective tissue of the lids, far from the glands, and consisted of embryonic connective tissue surrounded by a thick fibrous capsule which was absent in a young chalazion. This granulation mass in the connective tissue he called a chalazion externum, whereas the mass occupying the tarsus and glands he termed a chalazion internum. The former arose from the latter, destroying the tarsus and invading the connective tissue.

Terson (1906) defined chalazion as granulation tissue with no specific characters, giant cells being present in variable numbers. He believes that it is certainly not a tubercular condition, but that some organism gives rise to it, the soil having been prepared by some general or local disease. He considers that chalazion has more resemblance to lichen scrofulosum than to acne.

Sabrazes and Lafond studied the cells in chalazion and found that they consisted of plasma cells, giant cells, lymphocytes, large phagocytes, and leucocytes,—all the cells found in granulation tissue. They believe that chalazion resembles, both clinically and histologically, acne, and that it arises in the Meibomian gland.

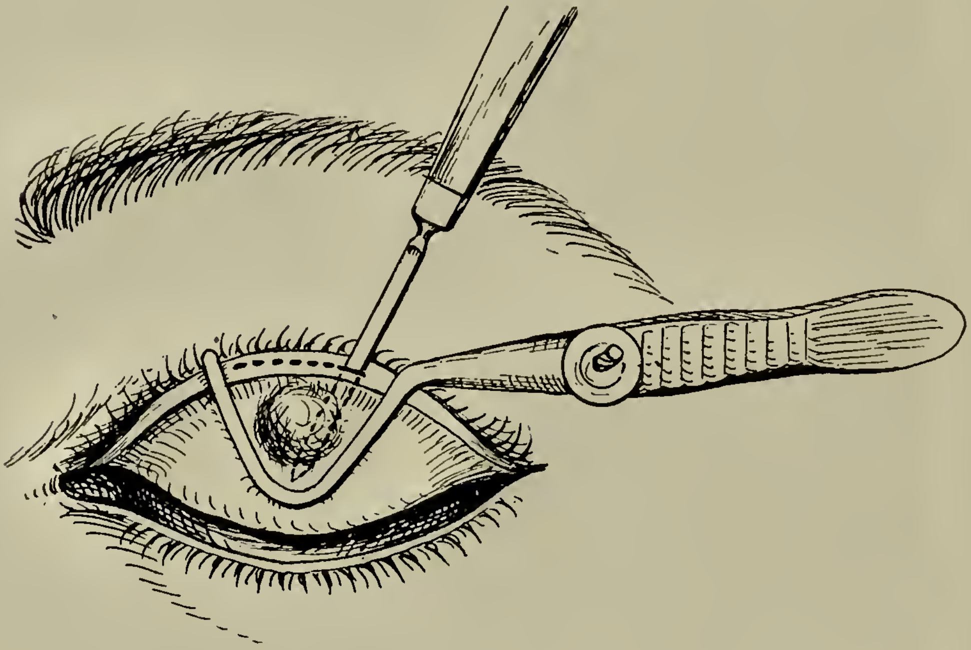
Buri's work was undertaken to decide this question, and for this purpose he obtained portions of chalazia, only two of which were extensive and enabled the relation between chalazion and the Meibomian gland to be studied properly. Into the minute histology of these specimens Buri goes very thoroughly, and from the evidence decides that chalazion and acne are two essentially different structures. He also finds that chalazion is a granuloma, arising in the loose connective tissue behind the tarsus and above the fornix, which is prone to undergo edematous softening in its interior. Its constituents are always the same and can be recognised in zones from without inwards as follows: At first hypertrophied spindle cells, then large plasma cells, further small plasma cells with a few multinuclear and giant, cell-like plasma cells intermixed. Further towards the inside, if the chalazion is old, follow the signs of blood and lymph obstruction, enlarged capillaries, edema, hemorrhage, and dissolution of cells. The intercellular material is scanty from the very beginning. There are no gland elements or even remains in the granuloma nor has it developed around any glands as far as one can judge. This is the uniform character presented by a chalazion. Buri could find no relation between the swelling and the Meibomian glands so far as his material went. Indeed in his second case what remained of the Meibomian glands was quite normal. He concludes from this case alone that any etiological relationship between Meibomian gland and chalazion is excluded. If such did exist one would have to explain it by supposing that the dense tarsal tissue prevents a granuloma forming in the Meibomian gland and a toxin diffusing into the connective tissue gives rise to the granuloma there. If not this, then the disease affects the mouth of the gland first and extends up to the fundus whence it spreads to the connective tissue. But this is not so. In his second case quite the upper two-thirds of the Meibomian gland were there and quite healthy, too. In some of his specimens the Meibomian gland was affected, but that only slightly, and it was separated by a healthy area from the granuloma. When the Meibomia gland is affected, it may be so secondarily. It is more likely that the accessory tear glands in the fornix are related to the chalazion.

From these findings he feels he can reply with safety to the question whether chalazion is an acne, as Sabrazes and Lafond believe.

From his investigations Buri says he must maintain the contrary. namely, that the two are entirely different affections of the skin. He begs to emphasise the point that in every case of true acne one meets with the comedo in which there is circumscribed hyperkeratosis of the duct. Without comedo there can be no acne. This is absent in chalazion. He knows of no evidence of a chalazion having an excretory opening at the lid margin. In acne the stratified, lamellar, cornefied body in the duct is produced by hyperkeratosis and this is never wanting. In chalazion it has never been shown to be present. There is no evidence of an abscess of the Meibomian gland or a cyst wall due to retention and stretching. Further, the cells of the granuloma arising around an acne pustule are quite different to those in the chalazion. And again, if the bacteriology is investigated the two conditions are not in agreement in this respect. He concludes therefore that chalazion is a granuloma sui generis and differs in many important points from acne so that one can recognise the two as different affections.

All this is supported clinically. Acne is seldom met with in combination with chalazion in spite of the former being so common. Chalazion is more common in cases of seborrheic eczema and like rosacea thrives well on seborrheic soil. If chalazion was an acne it would be commonly met with in multiple rather than single form.

The *treatment* of the *acute variety* is incision and hot fomentations, and an attempt may be made in quiet, *chronic* cases to produce absorption of the tumor by massage and the external application of iodine, mercurial and cadmium ointments. It is to be remembered, too, that *small* chalazia sometimes disappear both with and without treatment. In cases of *chalazion conjunctivitis,* or recurrent chalazia (q. v.), attention should be given the general health, the accompanying conjunctivitis should be treated secundum artem, and refractive errors and other sources of eye-strain removed.



Agnew's Operation for Chalazion.

The lid is held in Wilder's clamp for injection of cocain into the tumor and along the edge of the lid. The dotted line indicates the intermarginal incision, made with the clamp in position; or the clamp may be removed after the injection of cocain and the lid held between the finger and thumb.

The majority of Meibomian cysts require *removal by operation.* When the growth becomes large enough to require surgical interference it may be removed by incision at the lid margin, on the conjunctival surface or through the skin.

According to Ray, the method of removing chalazia through an intermarginal incision was first done by Agnew of New York, who used it regularly at the Manhattan Eye and Ear Hospital. Beard also credits this method to Agnew and recommends it.

It is certainly a valuable method, especially for chalazia that are near the lid border, where they are easily reached by such an incision, and should be more widely known.

Agnew's operation for chalazion. The eye is cocainized, and with a fine hypodermic needle a drop or two of 1 per cent. cocain solution is injected into the growth and the tissues at the margin of the lid where the incision is to be made. The injection will be facilitated by the use of a Wilder's U-shaped clamp, placed on the lid over the chalazion after the eye has first been cocainized. After the clamp is fixed, the fine hypodermic needle can be passed between the blades into the tissues of the lid margin. The clamp prevents the cocain from getting into the general circulation and limits its action to the part to be operated on. In two or three minutes the tissues are completely anesthetized, and if the growth is in a part of the lid that can be seized between the thumb and finger, the clamp may be removed; if not, it may be left in place as a means of holding the lid and giving a bloodless field.

Holding the lid between the finger and thumb so as to give a clear view of the lid margin, a Graefe cataract knife, or a Beer's knife, is then passed through the middle of the lid margin into the tumor. The margin of the tarsus must be accurately split, the incision being of such a length as to include all the diseased Meibomian glands. The knife is then withdrawn and most of the contents of the chalazion follow it, but the lid should still be held firmly between the finger and thumb.

A small curette with serrated edges is then introduced into the wound, and the walls of the cavity are thoroughly curetted. During the incision and the curettement, the surgeon's finger and thumb form a perfect guide, as they can feel every motion of the instruments in the tissues.

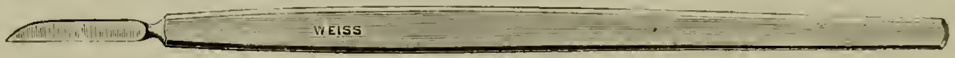
When all the contents have been removed, light pressure over the cavity is maintained for a few minutes to prevent it from filling with blood. A light pressure bandage is then applied which may be removed the next day.

The operation, when performed in this manner, is painless and no visible scar remains.

Antonelli has recently advocated the same procedure for the removal of chalazion by the intermarginal incision.

Conjunctival method of removing chalazia. Many operators prefer removing the tumor from the conjunctival side of the lid and this method is applicable if the growth is not too large, that is, does not involve too many of the Meibomian glands, and is situated rather far from the free border of the lid. In this operation, after cocainizing the eye, a Desmarres lid clamp may be fastened on the lid with the fenestrated blade on the conjunctival side and encircling the growth. A drop or two of 1 per cent. cocain solution may then be injected directly into the tumor and around it. With a small scalpel an incision is then made into the tumor, through the conjunctiva at right angles to the lid margin. The contents of the chalazion are then removed and its walls thoroughly curetted with a small, sharp spoon, after which the clamp may be removed. A bandage is not necessary.

After such operations, Coggin suggests the application of collodion to the skin over the sac, to cause by its contraction apposition of the walls of the sac, to prevent it from filling with blood.



Landolt's Chalazion Knife.

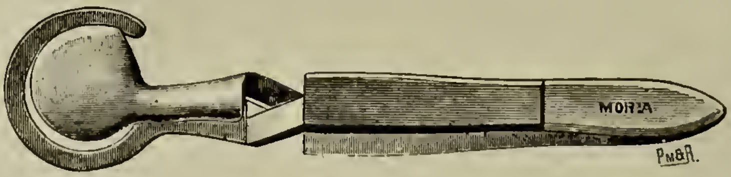
Cutaneous method for the excision of chalazia. If the chalazion is large and with thick, firm walls, it may be best to remove it from the cutaneous side. This may also be done with infiltration anesthesia after applying a Snellen lid clamp.

The incision is made through skin and muscle, parallel to the lid border and down to the tumor. The lips of the wound are then retracted, and the surgeon proceeds to dissect out the growth in much the same manner as he would a sebaceous cyst of the skin. In this case, however, the cyst wall is a part of the firm tarsus, and scissors and knife will be called into use. The conjunctiva should not be buttonholed if it can be avoided, but every part of the tumor walls should be removed.

The clamp can then be removed and, after the bleeding is checked. the wound is to be closed with one or two sutures. A light dressing is required for a day or two.—(W. H. W.)

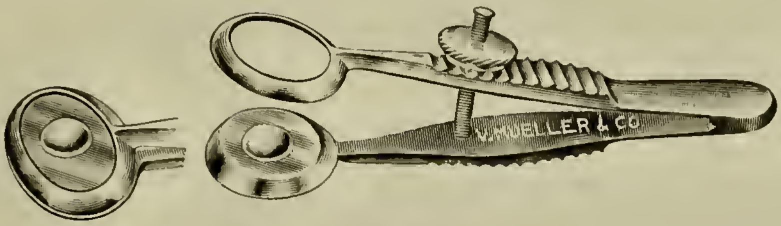
Chalazion conjunctivitis. See **Conjunctivitis, Chalazion.**

Chalazion forceps. There is a large number of these forceps on the market and many others that have not gone further than their description in ophthalmic literature.

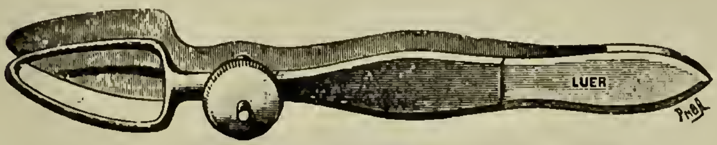


Pergens' Chalazion Forceps.

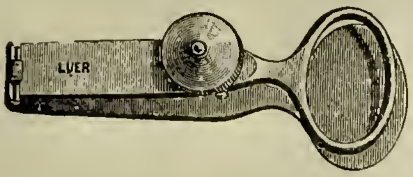
Several comparatively well-known forceps for isolating Meibomian cysts, so that they may be readily incised and curetted, are pictured but not specially described in the text of this *Encyclopedia*. The accompanying legends are sufficient to indicate their mode of employment.



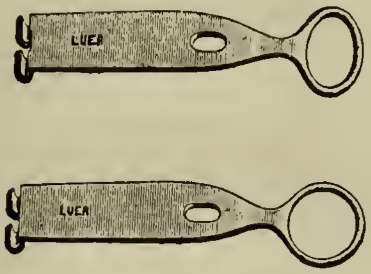
Wiener's Chalazion Forceps.



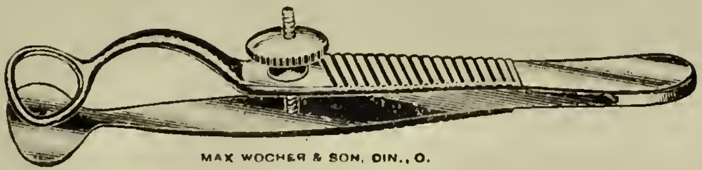
Duboys de Lavigerie's Forceps for Chalazion.



Desmarres' Forceps for Chalazion.



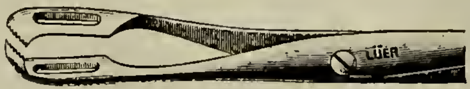
Reiss' Forceps (with Detachable Arms) for Chalazion.



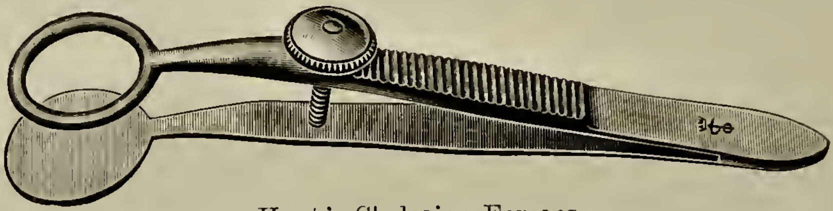
Francis' Chalazion Forceps.

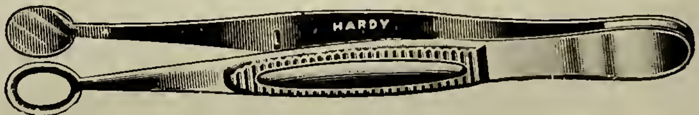
L. M. Francis' chalazion forceps (*Ophthalmic Record,* Dec., 1905, p. 568) is made with the curve in the upper blade so placed as to permit clamping the lid without crushing the ciliary margin.

C. J. Kipp has devised a simple chalazion forceps, one blade of which is solid, the other has a slit in it. The blade with the slit is placed over the conjunctival surface of the cyst and the incision is made through the slit. The handle is compressed and the contents of the cyst pressed out through the slit. (See *Trans. Am. Oph. Soc.*, 1898, p. 471.)

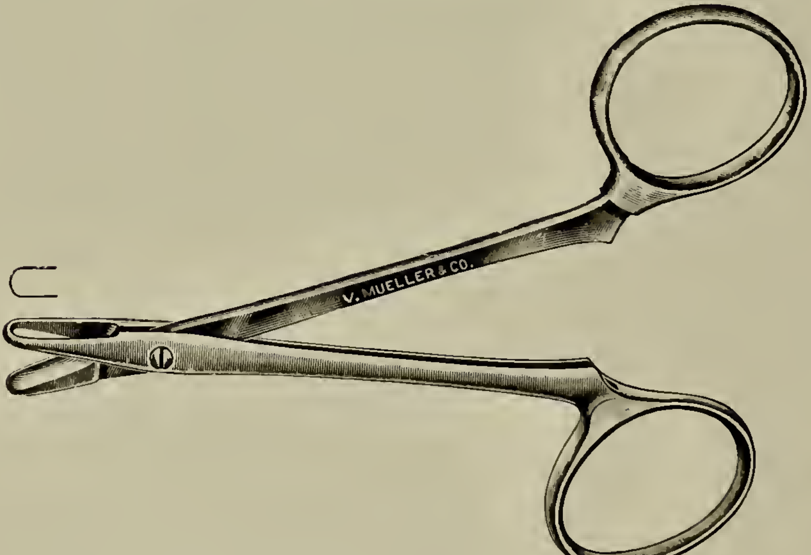


Forceps for Large Chalazion (Jacovides).


Hunt's Chalazion Forceps.



Ayres' Chalazion Forceps.



Boettcher's Chalazion Forceps.

The forceps, designed by Boettcher, (*Ophth. Record,* 1907, p. 66) after the many nasal punch forceps used in the nose, are to be used when the operation is done from the conjunctival side. An incision is made through the conjunctiva and tarsus into the tumor, when one blade of the forceps is introduced into the tumor and some of the tarsus punched out, the idea being to prevent closure of the incision and to promote free drainage. The tumor itself is curetted in the usual manner through the opening made.

Chalazion terreum. (L.) A tumor of the Meibomian glands exhibiting marked change in its contents. It begins as an ordinary chalazion (the excretory ducts of several glands usually being involved) whose contents having degenerated are changed into calcium carbonate and crystals of cholesterin.

Chalaziophyma. (L.) Obsolete. Hordeolum, or stye.

Chalcosis retinæ. (L.) A deposit of copper salts in the retina.

Chaleur. (F.) Heat.

Chalk deposits in the subconjunctiva. CONJUNCTIVAL LITHIASIS. URATIC CONJUNCTIVITIS. See **Conjunctiva, Lithiasis of the.**

Chalk's bottles. These English made containers have a rubber cap on a hollow stopper and may be either of clear or amber glass for eyewaters and similar lotions. They are often surrounded with metal cases that may be sterilized and are durable and suitable for traveling.

Chalky cataract. One that has undergone calcareous degeneration. See **Calcareous lens.**

Chalumeau. (F.) Blow-pipe.

Chamber, Anterior. Aqueous chamber (q. v.).

Chamber, Aqueous. ANTERIOR CHAMBER. The large lymph space between the cornea and the lens, containing the *aqueous humor.* See Vol. I, p. 506, of this *Encyclopedia,* under **Anterior chamber.**

Chamberland-Pasteur filter. CHAMBERLAND'S MICROBE FILTER. A filter designed to remove the most minute organisms from drinking-water. It consists of a candle-shaped vessel of biscuit-ware fastened into the lower part of a metallic receiver filled with water under pressure, and supplied from a pipe. The water passes through the pores of the vessel from without inward and escapes inferiorly from the orifice of the vessel. (Foster.)

Chamber, Posterior. This important space is bounded on one side by the *tunica interna,* and, indeed, by the ciliary epithelium and the pigment epithelium of the iris; on the other side by the anterior border layer of the vitreous up to the *ligamentum hyaloideo-capsulare* and from there on by the surface of the lens. Since the pupil-border of the iris lies upon the lens, the posterior chamber has a limitation which is neither absolute nor fixed on this side. It is not the former, because the pupil-border of the iris is not grown to the lens. Yet it appears from the observations of Ulbrich that no continuous stream of fluid flows from the posterior into the anterior chamber—the difference in pressure is only equalized from time to time, usually after a change in the width of the pupils. The position of this border also changes as a result of the pupil play. In this wider sense, the posterior chamber is a space of very complicated form, and for the purposes of description, it is, therefore, advisable to subdivide it into smaller portions. The most posterior (peripheric) portion of the posterior chamber is that narrow cleft-form space which lies between the inner surface of the *orbiculus ciliaris* and the corresponding portion of the anterior border layer of the vitreous. I have called this space the *orbicular space,* taking this name from Garnier, although it is not used by this author in exactly the same sense. Behind, the orbicular space has no sharp border; its most posterior portion is extensively bridged over by the vitreous fibrillæ and very gradually passes over into the body of the vitreous through the zonular cleft. The depth of the obicular space is very slight at the posterior end, not greater than the thickness of the layer of zonula fibers, i. e., some 0.01 mm. Here the space is in reality wholly filled out by the zonula fibers. In the anterior part, however, the border layer of the vitreous is pressed away by the various projections of the ciliary body, the largest zonula fibers are displaced to the inner smooth wall of the space and outwardly there remains a relatively free space, traversed only by the fine, straight, and backwards-coursing fibers. The space is only present where depressions have arisen between adjacent projections of the ciliary body. In such places the depth of the orbicular space may amount to 0.1 mm. In front, the orbicular space goes over into the second portion, the system of *ciliary valleys.* Since the anterior border layer of the vitreous is closely apposed to the posterior halves of the ciliary processes, the corresponding portions of the ciliary bodies are closed off into short canals which only communicate with one another in so far as the vitreous is not grown to the ciliary processes; it only lies close to them. In the meridional direction these canals measure some 0.8 to 1.0 mm, in the equatorial direction some 0.3 at the posterior end, in front 0.2 mm, while their depth (in a radial direction) increases from behind forward up to something like 0.5 mm. In the middle of the *corona ciliaris* the surface of the vitreous bows away toward the lens, and the anterior halves of the ciliary valleys are thereby transformed into furrows, which in their course open up into the succeeding division of the posterior chamber. Aside from these, there still remains abundant space for the aqueous. The third division of the posterior chamber is the *circumlental space.* By this usually one understands only the space between the crests of the ciliary processes and the border of the lens, as a matter of fact, therefore, only a linear dimension, which is, however, of great importance to physiology; yet its constant presence in all ages (exceptionally it disappears in senility) and in all states of contraction of the ciliary muscle proves it only acts by the mediation of the zonula and in any case possibly of the vitreous. Considered as an actual space, its borders are: outward, the crests of the ciliary processes; inward, the equatorial portions of the lens; behind, the border layer of the vitreous. In front it really has no border; for the sake of nomenclature alone, one can think of the most anterior zonula fibers as forming this border. Its form is angular. Frontally it measures scarcely 0.5 mm; its expanse in the sagittal direction depends upon the form of the lens border. It is somewhat narrower on the nasal side than upon the temporal. The fourth division is the *prezonular space,* or the *posterior chamber* in the stricter sense. This space lies between the posterior surface of the iris, on the one hand, the anterior surface of the lens, the most anterior zonula fibers and the anterior declivities of the ciliary processes, on the other hand. It opened into the circumlental space behind through the spaces between the zonula fibers, at the periphery into the ciliary valleys, axialward through the pupil into the anterior chamber. The prezonular space has its greatest depth over the crests of the ciliary processes (0.4 to 0.6 mm), from thereon very gradually narrows toward the pupil and disappears a short distance before the pupil-border of the eye is reached. Toward the periphery it narrows rapidly and at the same time forms there a narrow angle. Since, however, the ciliary processes reach a little over into the posterior surface of the iris, the periphery of the prezonular space has a wavy or cogged form. The prezonular space is the only division of the posterior chamber which has no zonula fibers and contains only aqueous.—(By permission, Salzmann-Brown.

Chamblant, Lenses of. Verres a la Chamblant. Chamblant was among the earliest to make an attempt to relieve astigmatism by means of cylindrical glasses. However his lenses—cylinders whose axes were ground at right angles to one another—were really equal to simple spheres or to spherocylinders.

Chambre antérieure. (F.) Anterior chamber.

Chambre noir. (F.) Camera obscura.

Chameconcha. In craniometry (in its ocular relations) an orbital index below 80.01°.

Chameleon. Throughout antiquity and the middle ages, the right eye of a chameleon, torn from the living animal and made into a poultice with goat's milk, was supposed to cure albugo (q. v.). The gall of the same animal was employed to prevent the return of lashes after epilation, and, rubbed into the eye on three successive days, was thought to cure "glaucoma."—(T. H. S.)

Chamilen-Thee. This is an infusion of chamomile flowers—and a well-known German lay remedy for ocular affections.

Chamomile. The dried flower-heads of *Anthemis nobilis.* Although best known as a lay remedy in the form of "tea," the simple infusion is often prescribed, especially in Continental Europe, as a hot fomentation, a compress (hot or cold) or as a detergent wash in painful diseases of the eye. The efficacy of the remedy, applied in this fashion, is chiefly due to its thermic qualities, although the flowers contain one per cent. of a volatile oil said to have medicinal properties. In America especially it has long been discarded in favor of more cleanly applications, such as normal salt solutions, one per cent. sodic bicarbonate or two per cent. boric acid.

Champ. (F.) Field, as of vision or of a lens.

Champak. A magnoliaceous tree of India and Indo-China, *Michelia champaca.* Its highly fragrant flowers are used for nasal catarrhs, for headache and in various ocular diseases.

Champ d'accommodation. (F.) Range or amplitude of accommodation.

Champ de fixation. (F.) Field of fixation.

Champ de fixation binoculaire. (F.) Field of binocular fixation.

Champ de l'accommodation. (F.) Range of accommodation.

Champ de netteté. (F.) Field of view.

Champ de regard. (F.) Field of fixation.

Champ d'une lentille. (F.) Field of a lens.

Champignon. (F.) A fungus or mushroom.

Champ plat. (F.) Flatness of field; a flat field.

Champ visuel. (F.) Field of vision.

Champ visuel binoculaire. (F.) Binocular field of vision; that portion of the visual field that is common to both eyes.

Champ visuel monoculaire. (F.) The field of vision of one eye.

Champ visuel périscopique. (F.) The field of vision covered by the eye when it does not move.

Chamseru, Jean François Jacques Rousille de. A French physician who wrote a number of ophthalmologic monographs. Born at Chartres in 1750, he studied at Paris and there received his medical degree with the thesis of *An ad Feliciorem Ulcerum Curationem Conferat Blandior et Rarior Medicina.* He served as surgeon in the army of Napoleon, afterward settling in Paris. The date of his death is not procurable.

He wrote a large number of articles of a general medical character, as well as the following, which possess an especial interest for ophthalmologists: *Recherches sur la Nyctalopie, etc.* (Paris, 1786); *Rapport sur l'Observation Faite par Demours sur une Pupille Artificielle,* etc. (*Recueil Périod. de la Soc. de Médicine,* 1800, viii): *Recherches sur l'Ophthalmie d'Egypte* (Ib. 1801, x).—(T. H. S.)

Chancre. An ulcer of venereal origin.

Chancrelle. (F.) Simple or soft chancre.

Chancre of the conjunctiva. This rare lesion is fully discussed by C. N. Spratt (*Pre-Sessional Reprint, Section Ophthalmology,* A. M. A., June 17th, 1913), who reports a case in point. Up to the present he has succeeded in finding but twenty-one cases of chancre of the bulbar conjunctiva, and of these only three were at the limbus. The report of his case of chancre of the limbus is typical of these cases, so that an abstract of it is given here.

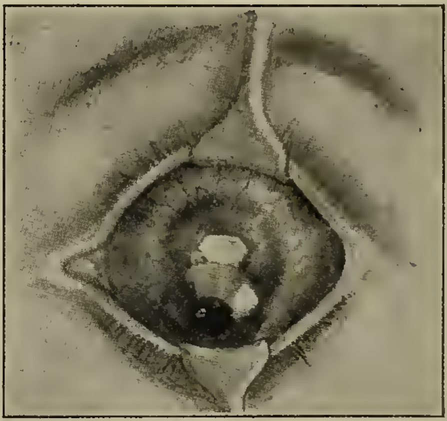
M. W., aged 37, an unmarried woman, began the care of her sister's 3-weeks-old infant, March 25, 1909. The child showed evidences of hereditary lues. It weighed less than 6 pounds, was prematurely born, and had the appearance of an old man; the head was large and the skin was wrinkled. Its cry was weak, and it had spots on the face and body, blisters about the anus and between the fingers, a discharge from the nose, and bleeding from the mouth. The child died when it was 4 months old.

May 25 the patient had a sudden pain in the left eye. She thinks that the eye may have been inflamed several days, as the upper lid covered the part of the globe most involved. The eye became very red, there was considerable lacrimation and the lids were moderately swollen. The pain was so severe that for several nights she walked the floor, being unable to sleep. The pain stopped rather suddenly two days previous to June 18, 1909.

Examination.—V. O. D. = 6/5. V. O. S. = 3/50. The lids were entirely closed, owing to swelling. There was marked chemosis of the bulbar conjunctiva, of a deep dusky red, which extended above to the cul-de-sac. On the bulbar conjunctiva, in the superior temporal quadrant, at the limbus, was a hard crescent-shaped area 1.4 cm. in diameter. This extended on the temporal side to below the level of the pupil, and was raised about 2 mm. above the level of the cornea. The center was occupied by a dirty, grayish-yellow necrotic area, with deep, sloping, regular edges. The ulcer was oval in outline, measuring 4 by 6 mm. The long axis was horizontal. The lower edge of the ulcer extended to the cornea. The latter was not ulcerated, but showed a deep infiltration in the portion near the ulcer. The pupil was dilated with atropin. The fundus was not distinctly seen on account of haze of the cornea. The left preauricular lymph-node was hard but not tender, and measured about 1.5 cm. in diameter. There was also some enlargement of the submaxillary lymph-nodes.

Diagnosis of chancre was made, and the patient put on inunction of mercurial ointment. Cultures showed staphylococci, and *spirochaeta pallida* was found in the scrapings from the ulcer.

Subsequent history.—July 20 the ulcer was healing, the chemosis was less, the conjunctiva was becoming pale, but slight induration was still present, and the preauricular lymph-node was enlarged. The inunctions were discontinued and mercury, 2/5 grain three times a day in the form of an enteric pill, was ordered. Sept. 1, 1909, the eye was white and there was a white scar on the upper part of the cornea. V. O. S. = $-0.50^{s} + 2.00$ cyl. axis 90° = 6/9 +. The patient was seen again November 23, with an iritis in the left eye. This along with a papular rash commenced two weeks previously. Inunctions were ordered again, as the patient had neglected her treatment for over a month. December 6, an iritis appeared in the right eye. The attack of iritis in the second eye was of short duration. Both eyes were white, December 22, Sept. 20, 1910, V. O. S. = 6/12 with glass.



Primary Lues of the Bulbar Conjunctiva.—(Spratt.)

Of the twenty-two cases of chancre situated on the bulbar conjunctiva, seventeen are reported in French literature.

Eye involved.—The lesion was situated in ten cases on the right eye, in six on the left, and in six cases the location was not given.

Age.—All these cases, except one, have been in adults. This is rather remarkable when one considers how much infants and children are kissed and fondled. Ages reported by different writers are as follows: 6 years, DeWecker: 18 years. Williams; 22 years, Sans Blanco; 23 years, DeWecker; 24 years, Ronvillois, Baudon; 25 years, Valude and Laur; 26 years, Horand, Clergerie: 27 years, Morax, Fano, Maslenikow; 30 years, Pelissier, DeWecker; 35 years, Sourdille, deSchweinitz, Sbordone: 37 years, the author's case.

Sex.—Nine males and thirteen females were reported.

Occupation.—Two married women, 5 nurse-maids, 3 laborers, 2 physicians, 1 football player, 9 not stated. The number of nurse-maids shows the danger of infection from syphilitic infants.

Situation of chancre.—Eight were on the nasal position of bulbus: 2 on the inferior nasal quadrant; 1 on the inferior; 1 on inferior temporal side; 4 on the temporal side; 4 at the limbus (1 each on the nasal, inferior and superior portions), 2 not stated.

Mode of infection.—1. Direct: By kissing or coughing, the saliva from a person with mucous patches may infect another, as in the cases of Hogge, DeWecker (two cases), Sourdville, and Sans Blanco. Fournier treated five cases of chancre of the eye (situation not given) among his medical colleagues, the infection being transmitted in each case by the patient coughing or spitting, while having the throat examined. Three of these washed their faces immediately after the occurrence. As he says, this does not show the futility of washing, but rather the necessity in such cases of complete ablutions with antiseptics, such as mercuric chlorid (1:1,000).

DeSchweinitz reports the case of a physician who developed a chancre of the bulbar conjunctiva as a result of some secretion entering his eye, during attendance on a case of parturition. The practice among some people of using the tongue to remove foreign bodies from the eye may prove a source of infection. Fournier mentions an account of an epidemic of syphilis described by a Russian physician, Tepljaschin, which was introduced into two villages by a "magician," who professed to cure trachoma and to remove foreign bodies from the lids, with the tongue. Sixty-eight persons were contaminated; eight of the first victims developed chancres of the eyelids. DeWecker's third case and probably Horand's, are examples of this.

2. Indirect: The infection may be carried to the eye indirectly by the fingers, as in the cases of Ronvillois and Sbordone. The cases reported by Williams, Baudon, Dagneloiski, Morax, Clergerie and by the author also come in this class, a luetic child in each case being the source of the infection, and its caretaker the one infected.

3. Mediate: Infected surgical instruments, towels, handkerchiefs

and sponges may spread the contagion. Such is, however, probably unusual and difficult to trace.

Period of incubation.—This is difficult to determine, as generally the time and mode of infection are not known. In deSchweinitz's case the lesion developed six weeks after the infection took place. Ronvillois' case developed less than one week after the supposed infection, a scratch from a finger. The short time of incubation in this case is against the scratch as the cause of the infection. Ten days is the shortest time given for the period of incubation of a chancre.

Onset.—This generally resembles a mild conjunctival irritation, with localized redness. There is slight lacrimation but no secretion. Pain has been noted in only those cases in which the chancre was situated at the limbus. The redness changes to a papule-like area, the center of which becomes necrotic, forming an ulcer.

Stage of the developed chancre.—Ten days to two weeks after onset, the condition is characterized by chemosis; an ulcerated area surrounded by a red, raised, indurated ring, and an enlargement of the preauricular, and frequently the submaxillary gland. The chemosis is marked, involving the bulbar conjunctiva and extending into the culdesac. It is red, gelatinous-like, and has the appearance of subconjunctival injection of oil. The color has been described as wine-red, yellow-red and copper-red. It appears at about the same time as the ulceration, and continues some time after the latter is healed.

Ulceration.—This is probably present in every case. It is generally single, but may be multiple. Vignes', Sourdille's and Ronvillois' patients each had two ulcers; Dagneloiski's three. These multiple ulcers may unite and form one large area. The size of the ulcer is generally about 4 by 6 mm., and is round or oval in outline. It is of a dirty grayish-yellow, and has been described as diphtheritic or mucous-like, with an opalescent appearance. The exudate is of a mucoid consistency. The edges of the ulcer are fairly high, sloping and regular in outline. The chancre is typical, a raised dusky red, indurated area, of the consistency of cartilage, not tender or painful. In appearance it is like a button with a punched-out yellow center. In size it averages about 15 mm. in diameter.

Corneal involvement.—Cloudiness of the cornea was present in the case reported by Fano. DeSchweinitz's case is unique in the development of a vascular keratitis. This subsided after the disappearance of the lesion of the bulbar conjunctiva, leaving a slight haze to the cornea.

Pain.—This has been noted only in those cases in which the lesion was located at the limbus (Fano, Maslenikow, Sbordone, Spratt).

Period of healing.—The ulceration gradually becomes smaller; at the same time the chemosis disappears, and the conjunctiva blanches. The induration persists some time after the chemosis and ulceration. The ulcer is finally replaced by a white scar, or, as described by others, by a copper-colored area. The course of the disease is generally from six to ten weeks.

Adenopathy.—The preauricular lymph-node on the same side is enlarged, hard, but not tender, and does not break down. In one case, Ronvillois', the preauricular lymph-nodes of both sides were enlarged. In about half the cases the submaxillary lymph-nodes were enlarged. The adenopathy is contemporaneous with the ulceration and the chemosis. The secretion is scanty; lacrimation is present.

Pathology.—Only one case (Sourdille's), has been examined microscopically. Sections were made so as to include the entire thickness of the lesion. The picture was characteristic of chancre. The infiltration of lymphoid cells was especially marked about the numerous blood-vessels, forming a kind of perivascular "cuff." Multinucleated epithelioid cells and leukocytes were also present. The endothelium appeared normal, but the tunica externa was thickened and many vessels contained thrombi. This infiltration gave rise to the cartilage-like hardness. The epithelium over the ulcer had disappeared, and the base consisted of a necrotic mass. The loose subconjunctival tissue was infiltrated by a serous coagulum in which were a few round cells, The thrombosis of the vessels was the cause of the ulceration and chemosis.

In the early stage the *diagnosis* is difficult. The condition might easily be mistaken for conjunctivitis, episcleritis or a phlyctenule. At the end of two weeks, when the chancre is developed, diagnosis should be certain, if the condition is thought of. Marked chemosis, ulceration, induration and enlargement of preauricular lymph-nodes are constant. To this may be added lacrimation and absence of pain, unless the chancre is situated at the limbus. The diagnosis is made absolute by the demonstration of the *spirochæta pallida.* The Wassermann reaction is not positive before the third or fourth week. The following several conditions might be confused with chancre:

Chancroid.—The induration about the ulcer is absent. The edges are sharp-cut, there is more or less itching, and there is an abundant secretion, in which the bacillus of Unna-Ducrey is found.

Tuberculosis.—The disease appears in several clinical forms. The lesions may consist of several rounded areas, similar to phlyctenules, or these may be multiple small ulcers, from 3 to 5 mm. from the limbus. The secretion is scanty, although in the large ulcers with rough, overhanging, granular, indolent edges, the secretion may be profuse. In these cases there is no chemosis, and the hard infiltration of the ulcer margins is absent. The pain is often severe. The disease is chronic and of long duration. The tuberculin test, the demonstration of tubercle bacilli or animal inoculations would determine the diagnosis.

Scleritis, a form of tuberculosis, is characterized by a slightly raised area of violaceous tint, showing no ulceration, no chemosis or adenopathy, but is tender on pressure, with considerable pain and photophobia. The condition is chronic and a local and general positive reaction to tuberculin would be obtained.

Herpes.—This is characterized by blister-like areas of the eye and forehead with severe pain.

Phlyctenule.—This is generally multiple, and is most common in children. Pain, adenopathy and chemosis are absent. Under treatment it rarely lasts over two weeks.

Gumma.—This appears as a round mass. The history of a previous chancre, or a positive Wassermann and the absence of adenopathy and chemosis, with the rapid growth, would characterize this condition. Ulceration, when present, is deep, circular and gray.

Secondary syphilitic papules.—I have recently had a case that showed three syphilitic papules of the bulbar conjunctiva. These resembled, in a way, the appearance of a chancre in the papule stage. The presence of other papules or evidence of such on the skin or on some other part of the body, the history of chancre, and the absence of ulceration and induration suffice to make the diagnosis.

Tumor.—Epithelioma would be most likely to be found in an old person. The slow growth of a neoplasm and the absence of chemosis and inflammation would distinguish it from a chancre.

Diphtheria.—The membrane would be extensive, the disease of from only six to ten days' duration, and the secretion abundant and sanguineous. Cultures and animal inoculation would settle the diagnosis.

Parinaud's conjunctivitis.—This is characterized by numerous pedunculated masses of conjunctiva which later form superficial ulcers. Numerous small yellow nodules are present in the subconjunctival tissue. There is no induration of the conjunctiva. The chemosis is marked, however, and the preauricular lymph-node is swollen. This often suppurates.

Prognosis and treatment.—A chancre of the conjunctiva heals without permanent injury to the eye, the only evidence being a small white scar. When the lesion is located at the limbus a slight nebula of the cornea may remain; as this is not central, vision is not diminished.

The eye should be kept clean by some mild antiseptic solution. The use of calomel as a dusting-powder is recommended. Salvarsan or neosalvarsan should be given as soon as the diagnosis is made. See, also, **Conjunctiva, Chancre of the.**

Chancre of the external eye. According to G. N. Spratt (*Pre-Sessional Reprint, Section Ophthalmology*, A. M. A., June 17, 1913), statistics show that six or seven out of every hundred cases of chancre are extragenital. Fournier says, "I think the proportion of 9 or 10 per cent. would not be too high for extragenital chancres." Although they have been noted on all parts of the body, literally from head to toe, the ophthalmologist rarely meets this condition. Thus Zeissl, in 4,000 cases of syphilis, observed only two chancres on the lids, while Boeck of Christiania had one patient with palpebral chancre in 2,344 cases. In 642 cases of extragenital chancre, Fournier observed only seven on the eyes or lids (location not stated). Bulkley personally observed 113 cases of extragenital chancre, four of which were on the eyelids. He has tabulated 9,058 cases, 372 of which were of the lids or conjunctiva.

In relative frequency, the structures of the eye which may be involved, are, according to Ronvillois: the ciliary margin, skin of the lid, palpebral conjunctiva, culdesac, bulbar conjunctiva (scleral portion, inner angle and caruncle), limbus and cornea. The location of extragenital chancres about the eyes in the ninety-four cases collected by deBeck was as follows: thirty-five on the lower lid margin, inner surface and culdesac; twenty-five on the inner angle and caruncle; twenty-four on the upper lid and culdesac; six on the ocular conjunctiva; four on the skin. The frequent involvement of the commissures and lid margins is due to the maceration of the epithelium by tears, and the resulting ulcerations, excoriations and blepharitis, offering opportunity for infection. The caruncle, plica semilunaris and lid margins are frequently irritated by scratching with the fingers.

Marbaix (*Trans. Belg. Oph. Soc.*, Dec., 1912), in the treatment of a chancre of the lid, injected successively 30, 40, 50, 60 ctgr. of salvarsan. Six weeks after the last injection inflammation of the labyrinth occurred, characterized by vomiting, noises in the ear, followed by deafness and lymphocytosis of the cerebro-spinal fluid. A new injection resulted in the disappearance of all the symptoms.

Chancre of the lid. This luetic lesion of the lid generally presents an ulcer with indurated base. Until the development of secondary symptoms the diagnosis may be in doubt. The conditions with which it is most likely to be confounded are the pustules of vaccinia and tuberculous ulcer. In chancre the pre-auricular gland is always, and the submaxillary is frequently, indurated. Only a careless or incompetent observer could mistake a chancre for a stye, chalazion, or dacryocystitis. Chancre may appear at any period of life. It is more often found on the lower than upper lid, and in men more frequently than in women. The infection may be carried by unclean fingers, towels, instruments, by kissing, or by the practice, common among Russians, of removing foreign bodies by licking. Tepljaschin, in a small town in Russia, met with thirty-four cases of chancre of the eyelids caused by a female quack who treated granular conjunctivitis by everting the lids and licking them. Not infrequently physicians, while treating the throats of syphilities, have become inoculated by the patient's saliva projected by coughing. In the *treatment* use may be made of the yellow wash locally and salvarsan, or mercury internally or by inunction.—(J. M. B.) (See, also, **Chancre of the external eye.**)

Chancre palpébral. (F.) Chancre of the eyelid.

Chancre, Sahara. The Aleppo boil, or button (q. v.).

Chancre, Soft. CHANCROID. This lesion of the lid is slightly more common than the true syphilitic ulcer. Eudlitz found three examples among sixty-six cases affecting the head and face. Chancroid resembles palpebral vaccinia. Koeber (*Wiener Med. Woch.,* 1883) succeeded in inoculating rabbits' eyelids with virus from a human soft chancre. (See **Chancre of the eyelid.**)

Chancroid. See **Chancre, Soft.**

Chandler, George. An eighteenth century English ophthalmologist of very little worth. He wrote two "Treatises," as follows: (1) *A Treatise on the Cataract, Its Nature, Species, Causes, and Symptoms.* With copper plates. By Geo. Chandler, Surgeon (London, 1775, pp. 116); and (2) *A Treatise on the Diseases of the Eye and Their Remedies,* to which is prefixed the Anatomy of the Eye, the Theory of Vision and the Several Species of Imperfect Sight. By G. Chandler, Surgeon (London, 1780, pp. 191).—(T. H. S.)

Chandler's method of cataract extraction. See **Cataract, Senile.**

Change, Anabolic. This term is used in Hering's theory of color-perception to explain the physiological process which takes place in the visual substances of the retina when acted upon by rays of light of different colors. For example, green light entering the eye induces a constructive or anabolic change in the red-green substance, thereby producing the sensation of green; while red light induces katabolic changes in the same substance, giving rise to a sensation of red. The anabolic changes are known by the term Assimilirung, and the katabolic Dissimilirung.

Change, Catabolic. This term is used in Hering's theory of color-perception to explain the physiological changes which occur in the visual substances of the retina, when acted upon by colored light. For example, red light induces a calabolic change (Dissimilirung) in the red-green substance, giving rise to a sensation of red; while green light gives rise to constructive, or anabolic changes (Assimilirung) in the same substance, thereby producing the sensation of green. In the same way catabolic changes in the yellow-blue substance induced by yellow rays of light give rise to the sensation of yellow, while anabolic changes in the same substance are induced by blue, giving the sensation of blue. The white-black substance, however, is affected in a catabolic way by all the colors of the spectrum, though in a different degree, producing in us the sensation of white, whilst its anabolism gives the sensation of darkness. If now red and green light together strike the retina, the anabolic and catabolic changes are in equilibrum in the red-green substance, and no color-sensation is produced, except that which results from the simultaneous action of both colors on the white-black substance, by which we see white.

Chant des artères. (F.) Arterial bruit.

Chanterie, M. G. de la. A celebrated oculistic quack of the early 19th century. He is said to have sent to the restaurants and coffee-houses in and about Paris the announcement of his various operations, together with a list of the names and addresses of those on whom he had operated successfully.—(T. H. S.)

Chaos lumineux. (F.) A confusion of subjective images experienced in going from a light to a dark room; a form of persistence of retinal-impressions.

Chapeau. (F.) Hat; covering; superior part.

Chapelet; Couronne de Vénus. (F.) Dry pustular eruption on the forehead of a syphilitic subject.

Character. A term employed in connection with alphabets and print for the blind (q. v.). In dot systems, a dot or group of dots used as a single sign.

Charaka. An ancient East Indian physician of very uncertain date, concerning whom extremely little is known. He composed in Sanskrit one of the oldest works on Indian medicine which have come down to our day, but which is thought to be an elaboration of a book by a still older author, Agnivesa. The name of Charaka's work is the same as that of all the other ancient East Indian works on medicine, *i. e., Ayur-Veda,* or Science of Life. The work was first printed in its original language (as extracts only) in 1868. The substance of the book may best be gleaned from Wine's *"Commentary on the Hindu System of Medicine,"* London, 1860. For the ophthalmology of Charaka, see **Susrata, Ophthalmology of,** and **India, Ophthalmology of.**—(T. H. S.)

Charbon. The French term for *anthrax* (q. v.), or *pustula maligna.* See **Bacteriology of the eye.**

Charcot's disease. SCLEROSE EN PLAQUES. This term is a synonym of disseminated sclerosis; cerebrospinal sclerosis; insular sclerosis; multilocular sclerosis; multiple sclerosis. It is a disease of the brain and spinal cord, in which there are areas of grayish-red degeneration in the white matter, with excess of fibrous tissue. The symptoms are mainly spastic paraplegia with great increase in the reflexes; volitional tremor; scanning speech; optic atrophy; nystagmus; mental debility; vertigo, and attacks of coma.

Charcot's ophthalmic migraine. This symptom-complex, known also as recurrent oculo-motor paralysis, consists of a paralytic ptosis which may exist alone or in conjunction with paralysis of the other ocular nerves, especially the fourth and sixth.

Charcot's sign. SIGNE DU SOURCIL. In facial paralysis the eyebrow is raised; in contracture of the fascial muscles it is lowered.

Charlatan. One who either practices medicine or pharmacy illegally or, as a legally qualified practitioner, resorts to vulgar devices for obtaining practice, e. g., by advertisement, public exhibitions, etc.

Charlatanism in ophthalmic practice. See **History of ophthalmology.**

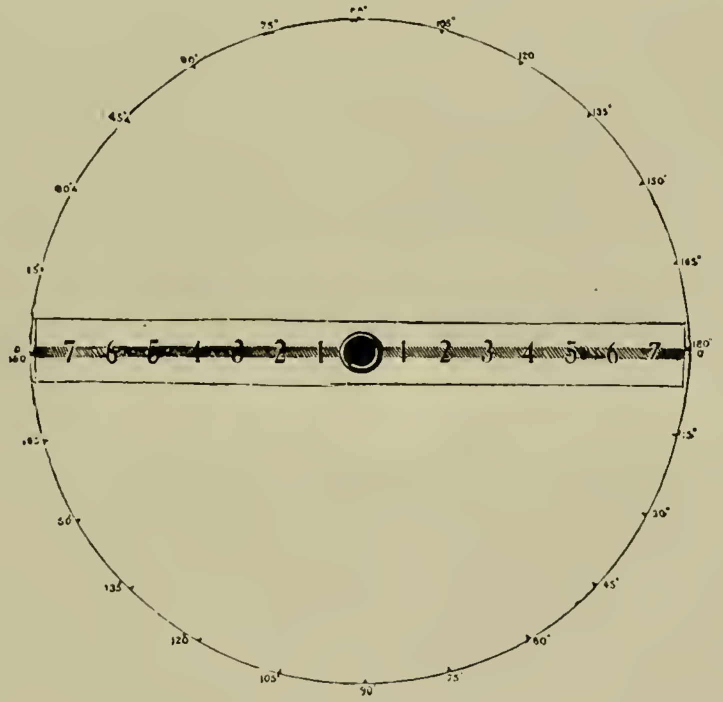
Charmis. A famous ophthalmologist, who flourished in the early portion of the first century A. D., and concerning whom we know almost nothing. He is said to have received the equivalent in U. S. currency of $10,000 for the cure of a single patient.—(T. H. S.)

Charnu, -ue. (F.) Fleshy.

Charogue. (F.) Carrion.

Charpentier's bands. In one of the experiments described by Burch (*Physiological Optics,* p. 155), exhibited by means of flashing light. Charpentier's bands may be shown to an entire audience by means of a projection lantern. All that is required is a semi-disk mounted on a slide, so that it can be rotated steadily at the rate of a revolution in one or two seconds. The audience should be instructed to keep their eyes fixed on its centre, and at the same time to watch what goes on by the receding edge of the semi-disk near the periphery, *without looking at it.* They will see one or more dark bands following the edge and keeping at a distance from it, depending on the speed of rotation. A pointer, which must be small and unobtrusive, may be so attached to the disk as to follow it at a definite angular distance. If then the rate is so regulated that the band appears to coincide with the pointer and the number of revolutions per minute taken, the time interval between the falling of light on the retina and the development of the band, can be calculated. A large cardboard disk, say 50 cms. in diameter with one-half painted black, answers equally well for a single observer. It must be brightly illuminated and all the surroundings must be dark. A very good plan is to use a hood for the eyes, like a stereoscope, but without lenses, fitted to the face and padded with black velvet, having at the bottom two holes just big enough to see the disk through. The observations can then be made in direct sunlight.

Chart, Heppell muscle. This simple chart, for the detection and measurement of oculo-muscular anomalies, is made of stout cardboard, with a central aperture covered with parchment.



The Heppell Muscle Chart.

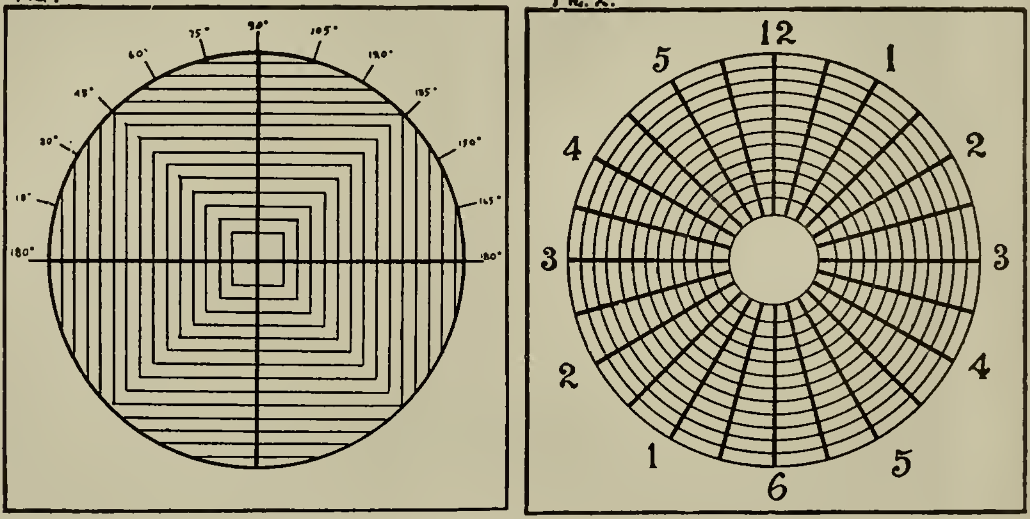
A light is placed behind the chart, so as to be seen through the parchment. On the chart itself is a revolving pointer graduated in prism dioptres. Two colored lenses are supplied with each chart.

The latter are placed in the trial frame before the patient's eyes, and in cases of muscular imbalances the consequent separation of the images is measured along the scale, the direction of the base line being obtained by revolving the pointer. This chart can be used with the Maddox rods, and is supplied for distances of three or five metres.

Chartæ. Papers. "Papers" are pieces of absorbent paper that have been treated with medicinal substances. Only one is official in the U. S. P.—Mustard paper, intended to be dipped into warm (not hot) water and applied to the skin as a rubefacient. In prescriptions papers are ordered by the square inch, thus: Chartæ sinapis, 2x3 inches; dip into warm water and apply to the temple. Chartæ epispasticæ vel cantharidis, 2x3 inches; to be applied above the right eyebrow until it blisters.

Chart, Astigmatic. Something has already been said about these useful aids in detecting and correcting the various forms of astigmatism. See volume I, page 656, of this *Encyclopedia;* also **Clock-face, Astigmatic.** In this place additional figures are depicted whose legends sufficiently describe them and their method of employment.

Fig. 1 Fig. 2.



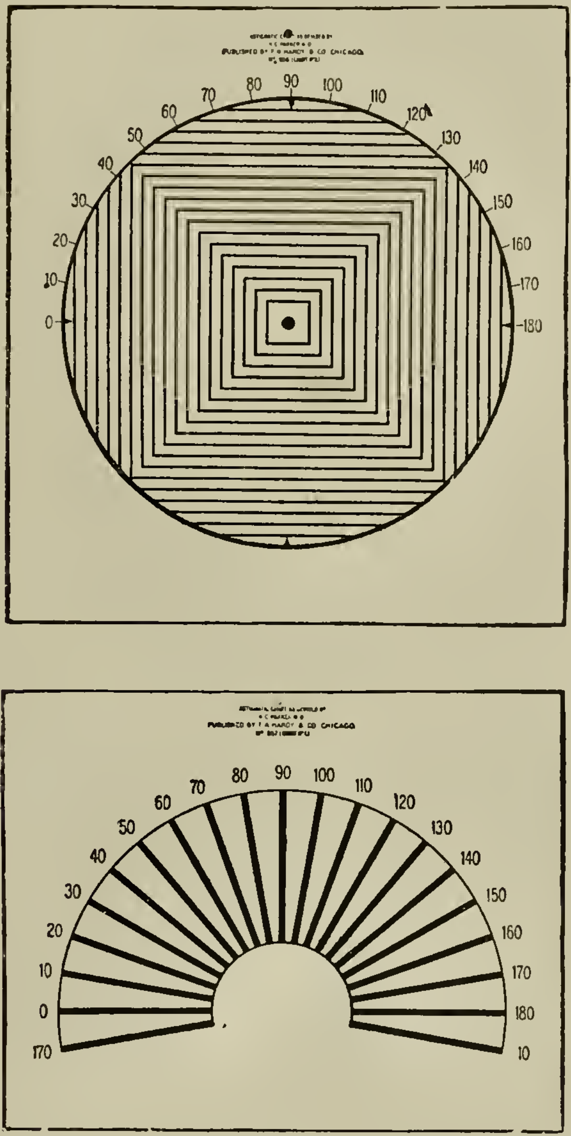
Verhoeff's Astigmatic Charts.

The two charts above illustrated are identical in principle, but differ somewhat in detail, one being designed to determine the axis, while the other is to be used for estimating more especially the amount of astigmatism. The principle upon which the charts are constructed may be recognized on looking at the cuts. It consists of a disk pivoted through its center to a flat board upon which degrees are marked off so that the disk can be rotated any number of degrees desired. Lines are drawn upon the disk as illustrated in the diagram; the two wide lines at right angles to each other are to be compared by the patient, the disk having been so rotated that one of these lines corresponds to the axis of astigmatism.

The chart, for determining the axis of astigmatism requires little explanation. The circumferences here produce much the same effect as the fine lines in the other chart.

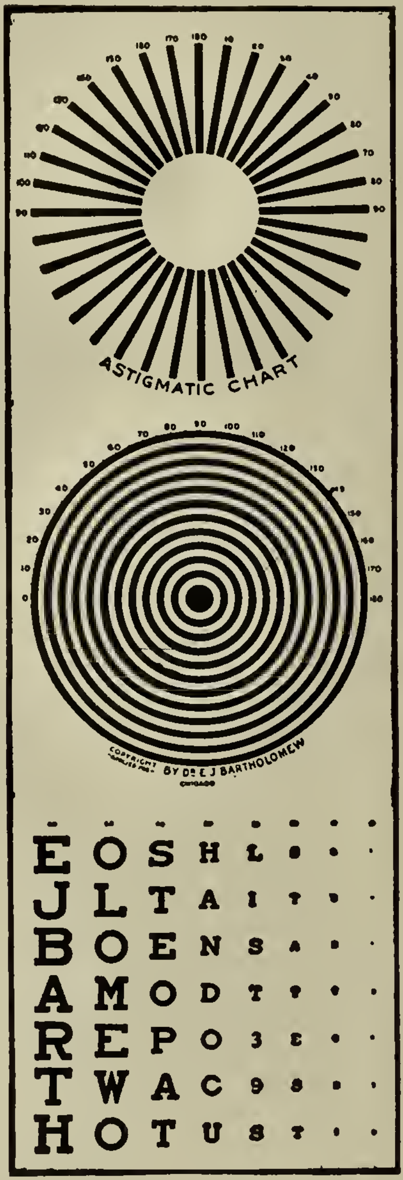
The axis of astigmatism may also be determined by the chart first described. This is done by suitably blurring the lines by means of a convex lens or its equivalent, and then rotating the disk back and forth until the more distinct of the two wide lines reaches a position at which it appears more distinct to the patient.

In using Cahn's astigmatic chart the directions are to attach the card with the four discs to the wall with the lower edge about three feet from the floor. Fasten the circular card on the wooden reel, to the wall directly over the large card with a screw that passes through the center and will allow it to revolve freely under the half circle marked with degrees.



Parker's Modified Verhoeff Charts, for the Detection of Astigmatism.

The cord must not be wound around the reel. Draw it up on the left hand side of the reel and pass it through the pulley which should be in the wall or ceiling directly above the chart. Stretch the cord across the room and through a pulley over the spot where the patient and operator sit and down to a convenient height and fasten the counter weight to the end. By drawing the cord the circular card



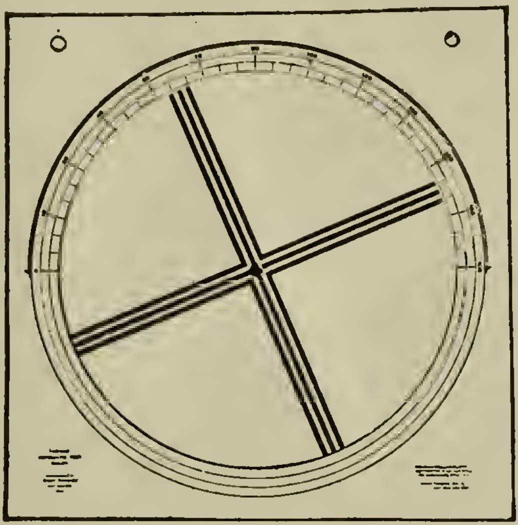
Bartholomew's Astigmatic Chart.

The value of this chart is due to the arrangement of numbers on the wheel and disk and to their combination in one chart.

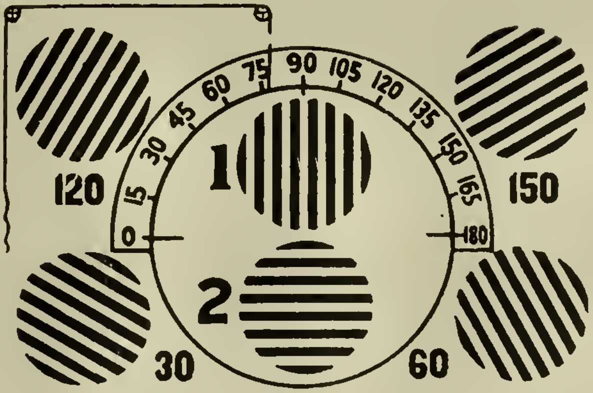
will revolve about half around and on releasing the weight it will turn back to place.

When testing a patient's eyes the cord should be released so that the discs 1 and 2 will set at axes 90 and 180.

Direct the patient's attention to the six discs and ask which one is blackest or brightest. This will give an approximate idea of the axis. Then tell the patient to look at the center discs, marked 1 and



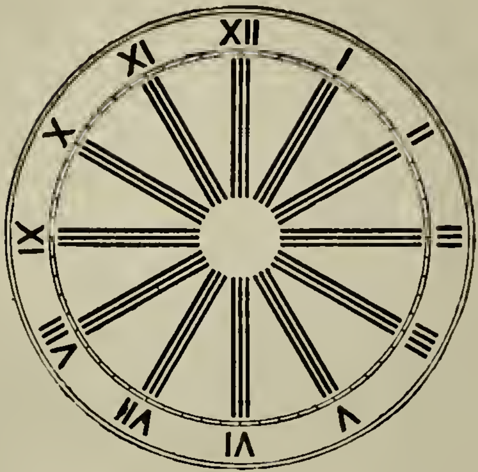
Thomas' Astigmatic Chart with Revolving Three-lines Cross. It Establishes the Two Meridians at a Glance.



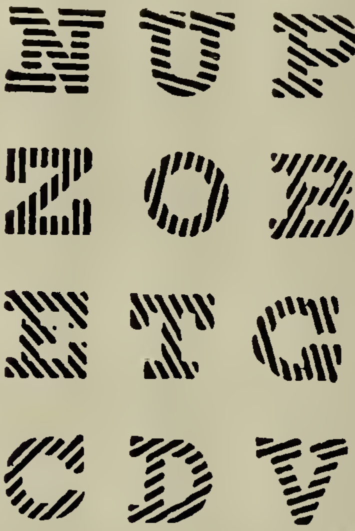
Cahn's Astigmatic Chart.

2. Having already obtained the approximate axis, it is easy to revolve the circular chart to ascertain the exact meridian.

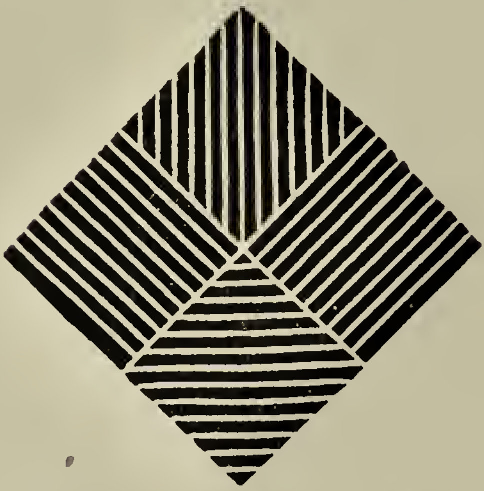
The fogging method is said to be valuable with this test because an artificially created astigmatism is much more apparent than the natural defect.



Astigmatic Clock-face Test Chart.

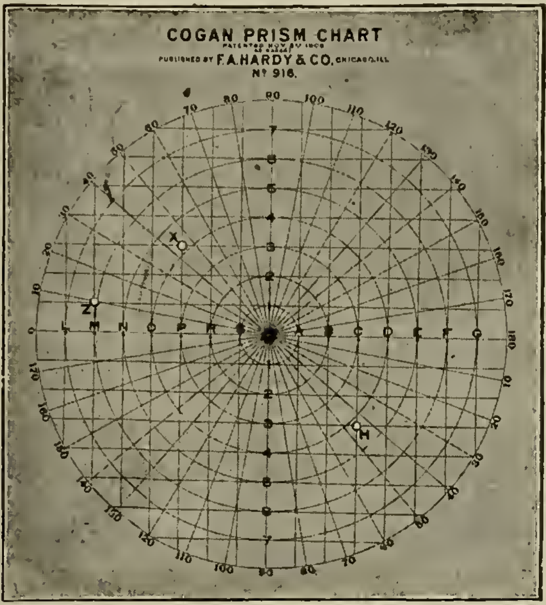


Pray's Astigmatic Letter Chart.



Diamond Astigmatic Test Chart.

Chart, Cogan's prism. This is one of many charts for testing muscular errors and insufficiencies. By it exact information may be obtained and the presence of muscular insufficiency and the location of the base of the correcting prism is shown by this test. See **Examination of the eye.**

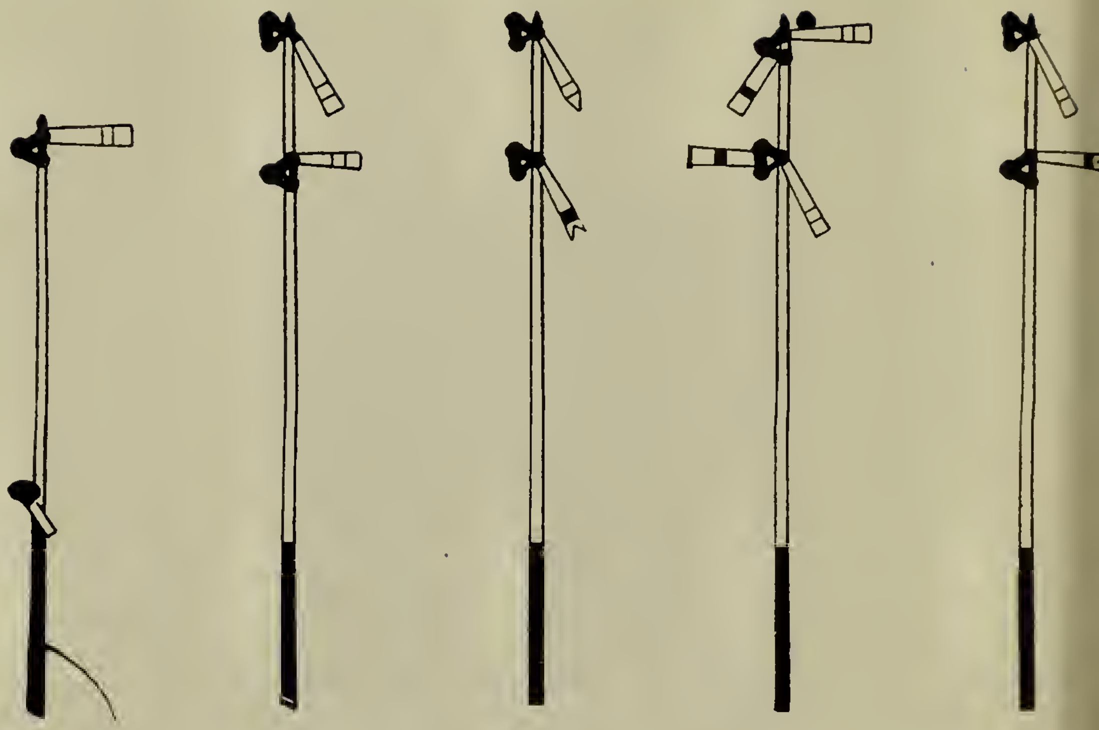


Cogan's Prism Chart.

Chart for plotting the location of foreign bodies in eye and orbit. See **Magnet.**

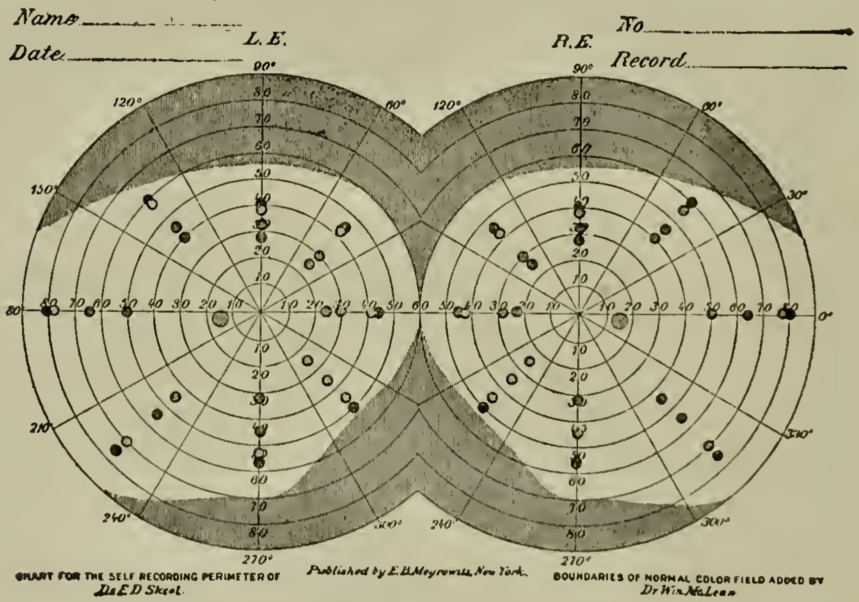
Charts, Black's new semaphore. These devices are intended to test the vision of railroad employes. They were designed by Nelson Miles Black and are founded on the Snellen test letters. The five cards represent a 20-foot standard semaphore pole and arm seen at one-half mile (2,640 feet) belonging to these sets of charts, with actual colors for the "Distance" and "Home" signals, and placed on a neutral grayish background which corresponds to the average tint of the horizon against which a semaphore in an ideal position is seen. In addition, 21 cards of Snellen test letters of seven different sizes, 15, 20. 30, 40, 50, 70 and 100 feet, the number indicating the distances at which each size subtends the visual angle of 0° 5′.

The cards are printed in triplicate for each of the given distances, with a different arrangement of the same-sized letters on each card. This is done in order to avoid memorizing of letters by applicant. Each card is perforated with an eyelet for convenience in hanging up. The whole set may be easily carried in the pocket.



Black's New Semaphore Chart.

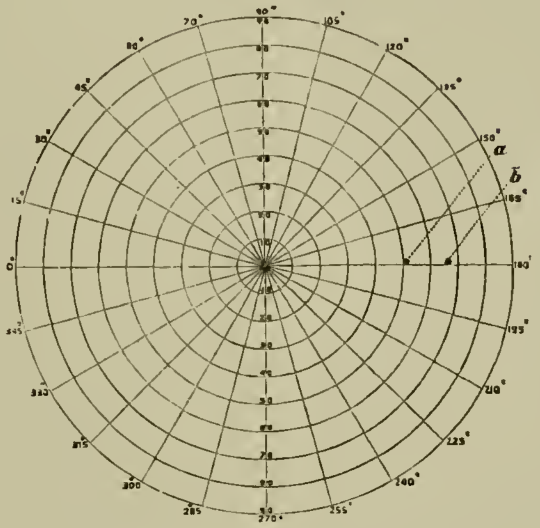
Charts, Perimeter. These useful attachments to the perimeter, for registering the boundaries of the visual fields, for mapping out sco-



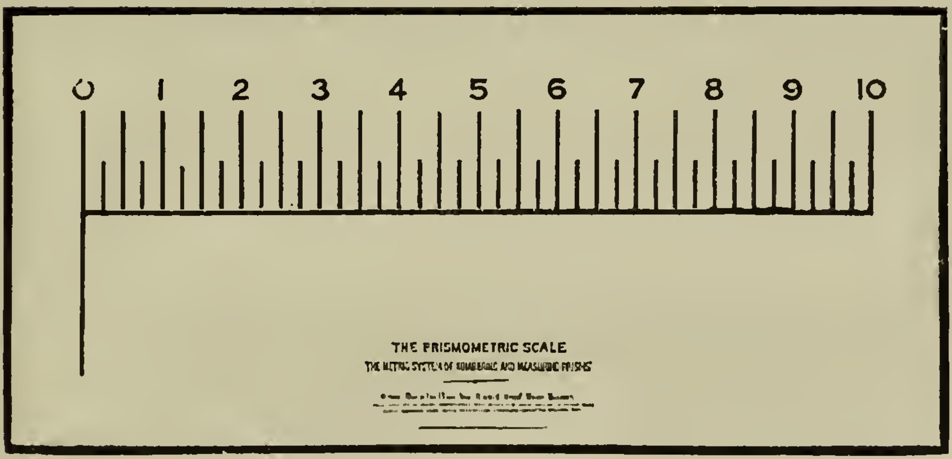
Skeel Perimeter Chart, with McLean's Modification.

On this chart the boundaries of each of the color fields are shown at angular intervals of 45 degrees by dots of that particular color. In taking color fields with this chart, it is unnecessary, therefore, to refer to any authority in order to make comparison with the normal field for that color or colors.

tomata, etc., are published in great variety. A few of the better known are pictured in the text. See, also. **Field of vision,** and **Perimeter,** as well as **Examination of the eye.**



Meyrowitz Perimeter Chart, for either Right or Left Eye.

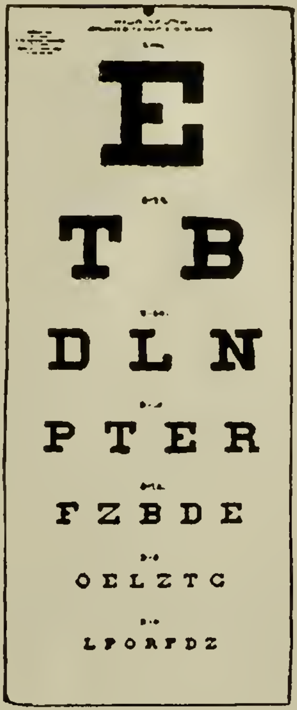


Prentice's Prism Chart with Scale of Tangents of Degrees for Determining the Deviating Angle of Prisms.

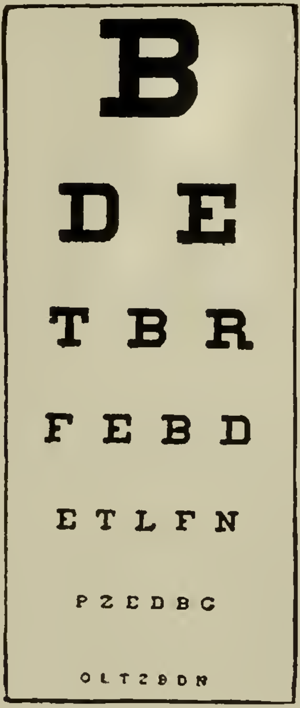
Charts, Prism. It very often occurs that a lens containing a prism is brought for duplication and unless there is some simple means of detecting the presence as well as the power of the prism one will duplicate many lenses incorrectly. A simple but accurate prism-measuring device may be made as follows:—On a strip of paper about 15 inches in length draw a vertical line about four inches long close to the left hand edge of the paper; at the top of and perpendicular to this upright line draw a horizontal line to run the length of the paper. Starting one inch to the right of the vertical line draw other vertical lines about two inches high upward from the horizontal line, all just one inch apart, until you come to the end of the horizontal line. Number the vertical lines consecutively, calling the first line at the left, which runs down from the horizontal, zero, and the next line to the right, which runs upward, No. 1. These figures should be about one-half an inch high and should be distinctly made, so as to be visible at a distance of nine feet. When the chart is complete, place it on the wall and stand just nine feet from it when neutralizing lenses. By holding a lens up so that the zero line runs through the physical center of the lens and noting the amount of displacement as viewed through the lens and observing the number on the chart to which the zero line is displaced, you will have a very accurate indication of the power of the prism. The base of the prism will be just opposite to direction of the displacement. The quickest and easiest way to understand this will be to construct a chart and try the method suggested with a prism from the trial case.—(R. D. P.)

Chart, Visual test. Although this subject will be fully discussed under **Examination of the eye,** as well as under another major heading, **Refraction of the eye,** yet it is thought proper to introduce here a number of cuts, most of which are self-explanatory. The Snellen test-types for determining the visual acuity for both distance and near, are generally accepted as the standard, yet it has been found that letters constructed under the angle of five minutes do not always give the best visual acuity of which the patient is capable, many eyes possessing vision 5/4 of this standard. Hence, test-types have been constructed on the basis of an angle of four minutes.

The test-type of Wallace is constructed on the four-minute basis. Some objection has been raised to the intervals between the lines in Snellen's types. This has caused Monoyer to construct a series of lines based on the decimal system in which the interval between each


E
T B
D L N
P T E R
F Z B D E
O E L Z T C
L P O R F D Z

Snellen's Test Chart, Ordinary Form.

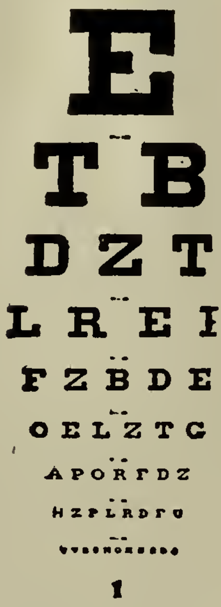

B
D E
T B R
F E B D
E T L F N
P Z E D B C
O L T Z B D N

Snellen's Test Chart, adapted to from Five to Fifty Meters.

line is 1/10 and the degrees run from 0.1 to 1.0. These types were highly commended by Noyes.

The letters used as tests are printed in black on a heavy white paper, or painted on porcelain, or, as is now preferred by many surgeons, the letters are white with a black background. It is claimed for the latter that a white letter on the black card is not so tiring to the eye as the ordinary test-type.

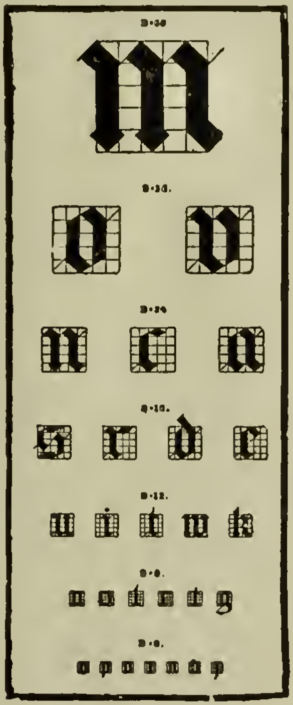
For recording visual acuity Snellen furnished the formula: $V = \frac{d}{D}$. In this *V* stands for vision, *d* indicates the distance of the patient from the type, and *D* the distance at which it should be read.



Snellen's Test Chart, Three to Sixty Meters.

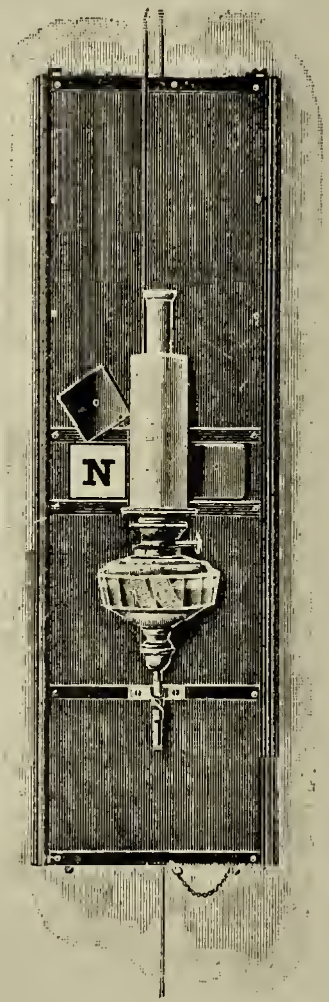
Acuteness of vision is found by determining the smallest type which can be read at 6 metres. Rays of light coming from an object at this distance are assumed to be parallel. In the practical use of test-types it is necessary to have a steady and equal illumination. Since daylight does not answer these requirements, it is best to use artificial light. A reflector is used to throw the light from a gas-bracket on to the type. The patient, being placed at the proper distance, is requested to read the letters, beginning with the largest. The eye not under examination is covered with a metal disc placed in a frame for holding lenses, commonly known as a "trial-frame."

If the patient correctly reads the line which the normal eye reads at 6 metres, vision should be recorded as follows: RE = 6/6. The left eye is then tested in the same manner. If, for example, this eye reads at 6 metres only the line which should normally be read at twice this distance, vision should be recorded as LE = 6/12. Attempts are then to be made to render the vision normal by placing a spheric or a cylindric lens, or a combination of the two, in front of the eye. The result is recorded as part of the case history. Regardless of whether normal vision is attained by lenses or without them, it is necessary in many cases, particularly in persons under 45 years of age, that a mydriatic be used in order to examine the refraction properly. Before proceeding to its use, however, it will be advisable to examine the near vision, the light-sense, the color-sense, the field of vision, the muscle-balance, and the intra-ocular tension.



Snellen's Test Chart.

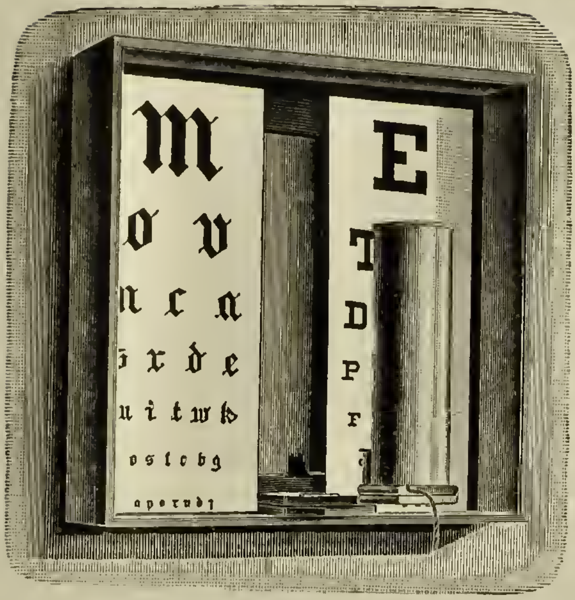
In case the patient cannot read the largest letters on the test-type at 6 metres, he is to be led toward the letters, and, when the top letter is recognized, a note is made of the distance. If, on closely approaching the test-type, it is found he cannot read any letters, the surgeon is to determine whether the eye under examination can see fingers at a few inches. Should there exist inability to recognize fingers, it will be necessary to find whether light-perception, PL, exists. This can be done by taking the patient into a dark-room and throwing a faint light upon the eye by means of an ophthalmoscope or retinoscope. The mirror can be turned so as to illuminate different parts of the retina, and the intensity of the light can be varied. The result of these observations is to be recorded for future comparison. Light-perception may be qualitative or quantitative. If qualitative, the patient will distinguish between two sheets of paper, one of which is entirely white, the other with printing on it. If quantitative, he will recognize the difference between a dark and a lighted room.



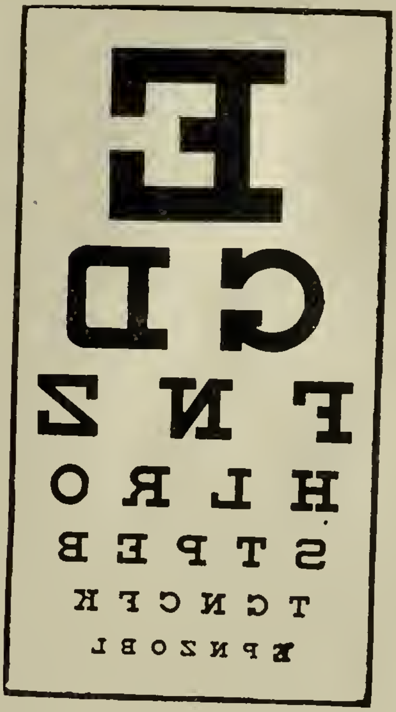
Visual Test Chart. (Meyer.)

Test letters are (one at a time) presented to view by means of a simple apparatus controlled and worked by the examiner.

Up to this point it has been supposed that the patient is an adult

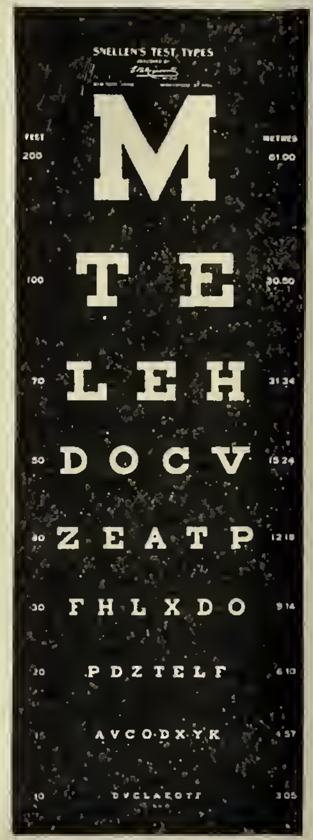


Roth's Test Chart with Illuminating Apparatus.

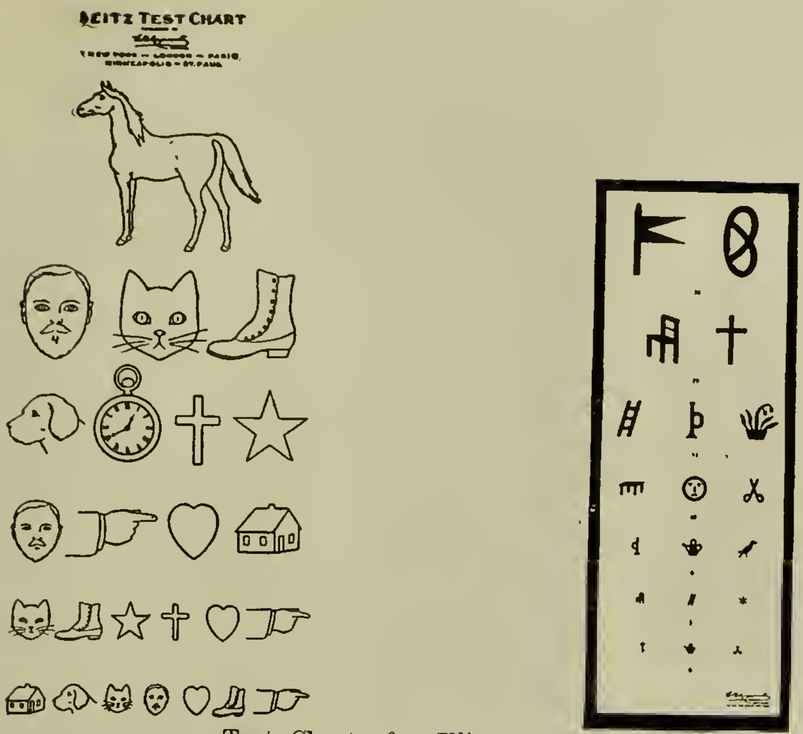


Snellen Test Chart, Reversed Letters.

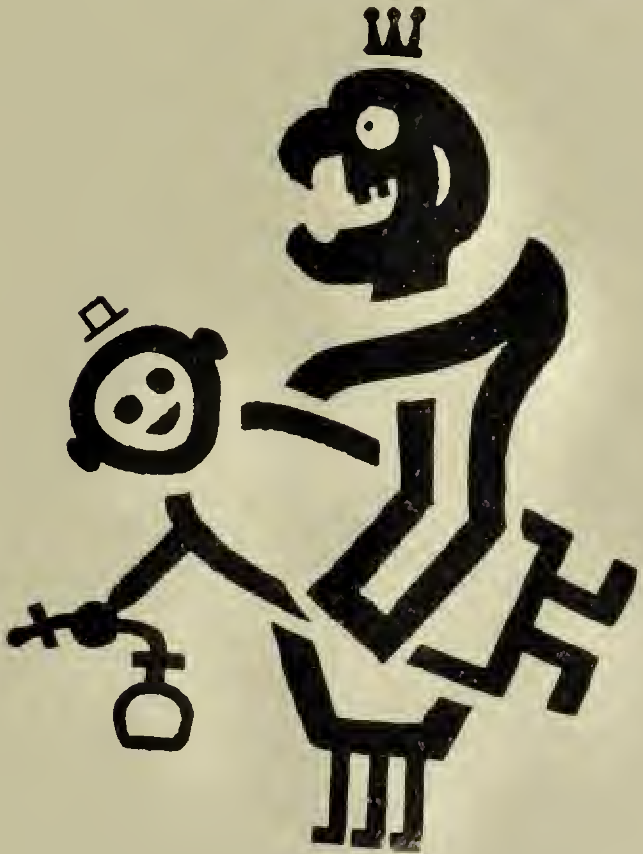
of average intelligence. If he be illiterate, the surgeon must make use of specially constructed test-types. A common one is that designed by Snellen, in which the letter *E* is placed in various positions and the patient is to place a metal *E*, which he holds in his hand, in the same position as obtains on the test-type. Another test is that of Burchardt, who arranged a series of dots of different sizes in the form of groups. The latter is a more exacting test. Still another way is to have pictures of animals or common objects printed according to the visual angle. Such test-types have been designed by Ewing, Wolffberg, and others. As regards the examination of malingerers, the subject is of such importance as to demand consideration elsewhere in this *Encyclopedia*. It may be remarked here that, in the examination of the refraction of illiterates, malingerers, and children, credence is to be given to the findings obtained by ophthalmoscopy, ophthalmometry, and retinoscopy.—(J. M. B.)



Snellen Test Chart. White Letters on a Black Background.



Test Charts for Illiterates.



Visual Test Chart for Illiterates (Ettles).

Charpie. (F.) Picked lint.

Chas. (F.) The eye of a needle.

Chasma. (L.) In ornithology, the optic chiasm.

Chassaignac, Charles-Marie-Eduoard. A famous French surgeon of the early 19th century, of some importance to ophthalmologists. Born at Nantes in 1805, he studied both at Nantes and at Paris, receiving his medical degree at the latter university in 1835. Success at first came to him very rapidly, later, however, very tardily indeed. In the year in which he graduated he became Associate Professor of the Faculty, with the thesis, *"Quels Sont les Agens de la Circulation Veineuse,"* etc. Very soon thereafter he was made successively Prosector, Surgeon of the Central Bureau of Hospitals, and Vice-President of the Anatomical Society. Then came the period of failure. No fewer than seven times did Chassaignac compete for the chair of Anatomy, each time without success. The competitions occurred in 1836, 1841, 1842, 1846, 1848, 1850 and 1851. In 1868, however, because of his epoch-making discoveries, he was constituted a Fellow of the Academy of Medicine.

The most important discoveries, or inventions, of Chassaignac are: (1) Linear Ecrasement; (2) The Treatment of Wounds by Drainage, and (3) The Treatment of Wounds by Occlusion. The importance of (2) and (3) were much increased by the introduction into surgery of asepsis and antisepsis. The treatment of wounds by drainage had been practised before the time of Chassaignac, but not to any considerable extent or in accordance with any clear and definite principles.

Chassaignac's most important general compositions are:

1. *Fracture of the Neck of the Femur, Studied Especially from the Viewpoint of Pathological Anatomy.* (1835, graduation thesis.)
2. *Dissertation on the Texture and the Development of the Organs Engaged in the Circulation of the Blood.* (1836. Thesis in competition for the Professorship of Anatomy.)
3. *An Appraisal of Orthopedic Apparatuses.* (1841. Thesis in composition, etc.)
4. *Traumatic Lesions of the Skull and of the Parts Contained Within It.* (1842. Thesis in competition, etc.)
5. *On the Mucous Membranes.* (1846. Thesis in competition, etc.)
6. *On Tumors of the Vault of the Skull.* (1848. Thesis in competition, etc.)
7. *On the Operations Applicable to Complicated Fractures.* (1850. Thesis in competition, etc.)

8. *On Encysted Tumors of the Abdomen.* (1851. Thesis in competition, etc.)

9. *A Treatise on Linear Ecrasement.* (Paris, 1856.)

10. *A Practical Treatise on Surgical Suppuration and Drainage.* (2 Vols., Paris, 1859.)

11. *Lessons on Tracheotomy.* (Paris, 1855.)

His ophthalmologic writings are as follows:

1. *A New Procedure for the Employment of Mercurial Inunctions, Combined with Belladonna, in Certain Diseases of the Eye.* (*An. d'Oc.* XV, p. 132, 1846.)

2. *On the Nature and Treatment of Suppuration of the Eye in the Newly Born.* (*An. d'Oc.* XVI, p. 138.)

3. *Employment of Ice in Diseases of the Eye.* (*An. d'Oc.* XXII, p. 167; XXVII, p. 66; XXXVII, p. 185.)

4. *Anterior Spinthcropia.* (*An. d'Oc.* XXVI, p. 3.)

5. *Plastic Surgery for Lachrymal Fistula.* (*An. d'Oc.* XXVIII, p. 235.)

6. *Investigations in Ocular Anesthesia.* (*An. d'Oc.* XXVIII, p. 236, 1852.)

7. *On Membranous Ophthalmia.* (*An. d'Oc.* XXXIV, p. 38 and XXXV, p. 34, 1855 and 1856.)

8. *On the Treatment of Incipient Lachrymal Abscess.* (*An. d'Oc.* XXXIV, p. 180.)

9. *A Case of Amaurosis in a Person 32 Years of Age, with Loss of Equilibrium, Ending in Sudden Death.* (*An. d'Oc.* XXXIV, p. 286.)

10. *Influence of Tonsillar Hypertrophy on Diseases of the Eye.* (*An. d'Oc.* XXXV, p. 103.)

11. *Detachment of the Iris from the Crystalline Lens.* (*An. d'Oc.* XLIV, p. 53.)

Chassaignac became renowned in ophthalmology for his liberal use of ice in many affections of the eye, especially in keratitis, hypopion, and the inflammatory troubles which sometimes result from the cataract operation. For the purpose of holding ice to the eye, he invented a sort of mask, retained in its place by a spring about the head. In this mask each of two cup-shaped depressions (corresponding to the two eyes) was filled with a tiny sack, made from the vermiform appendix of the sheep, and stuffed with pounded ice.

His treatment of the initial stages of lachrymal obstruction also added somewhat to his reputation. The treatment consisted in douching the sac from below upward, by means of a sound which presented a lateral opening at its distal extremity, the sound being connected with an air-pump.

Chassaignac died at Versailles, France, Aug. 26, 1879.—(T. H. S.)

Châsse. (F.) The joint of a lancet, bistoury, etc.

Chasse-taupe. (F.) Datura stramonium.

Chassie. (F.) The secretion of the Meibomian glands. Blearedness, or indistinct vision.

Chassieux. (F.) adj. Blear-eyed.

Châssis. (F.) Dark slide.

Châtaigne. (F.) Chestnut.

Chatard, Pierre. Born at Cape François, San Domingo, July 17, 1767, he received both his general and his scientific training in France. Returning to the New World he settled for practice in Baltimore in 1797. He devoted himself especially, but not exclusively, to diseases of the eye, and published a number of articles on ophthalmologic subjects. He died in Baltimore, Jan. 5, 1848.—(T. H. S.)

Châtoiement. (F.) The production of iridescence by interference, as in the chorioid of the cat.

Chatonné. (F.) adj. Inclosed in a sac; encysted.

Chatouillement. (F.) Tickling.

Chauche, Jean. Practically nothing at all is known about this man, except that, in 1618, he wrote, by way of competition for a Monspelliensian professorate a thesis entitled *"An Ophthalmia Sit Morbus Contagiosus?"*—(T. H. S.)

Chauchius, Johannes, Monspelliensis. A French physician of the 17th century. **Chauche, Jean.**—(T. H. S.)

Chaudepisse. (F.) A vulgar name for gonorrhœa; clap.

Chauffage. (F.) Heating; method of generating and maintaining a warm temperature.

Chauffeurs, Vision of. Owing to the rapidly increasing numbers of automobiles, used for business as well as pleasure purposes, every state should require that all applicants for a license to drive a motor vehicle pass an eyesight test. All railroads and many electric car-line companies require such a test. Yet, in the great majority of states, the prospective driver of an automobile need only affirm in his application that he has no physical or mental infirmities. When one stops to consider that a railroad engineer drives over a steel track, guarded by signals and watchmen, and over a route with which he is thoroughly familiar, whereas the autoist drives over any road he chooses, not protected by lights and signals, and in some cases traveling almost as rapidly as a locomotive, it is plainly imperative that he possess as good sight as the man in the engine cab. If one eye is highly defective the field of vision is greatly impaired and the driver less able to maneuver his car in an emergency. Paris, Munich and other European cities have seen the necessity of an examination of the eyes of all taxi-drivers and are strict in the enforcement of this protective measure. It is more than likely that defective vision is next in order of frequency to the overuse of alcoholic drinks as a cause of automobile accidents. We can, and should, protect pedestrians and drivers of vehicles from injury to a much greater extent than we do. Each applicant for a license to drive a motor vehicle should be required to give satisfactory proof of at least moderately good vision.

Freytag (*Münch. Med. Wochenschr.*, Vol. 58, Nov. 6, 1911) has gone thoroughly into this important matter and insists upon testing the eyes of automobile drivers as much as one would the eyes of the railway employee. (See, also, **Automobile drivers, Vision of.**)

Chauliac, Guy-de. See **Guy de Chauliac.**

Chaulmoogra oil. This oleaginous extract is derived from the seeds of *Gynocardia odorata*, a product of the East Indies. The fruit is a spherical berry which bears a heart-shaped hilum-residue. This fixed oil contains gynocardic acid, palmitic acid, hypogaeic acid and cocinic acid, and is believed to be a specific in leprosy; consequently (to be given internally) in the ocular manifestations of that disease. The dose of the powdered seeds is 3 to 6 grains.

Chausse. (F.) Straining-bag; filter.

Chauvel's test for simulated blindness. This device is a modification of the Fles box (q. v.) except that it is rectangular, 33 cm. long and 20 broad. It is described as follows: The posterior wall consists of a sheet of glass, divided into two parts like a stereoscopic card, on which are printed letters of dimensions that have been calculated in such a way as to measure the visual acuity at a distance of thirty-three centimetres, which is that ordinarily used for reading. The first line answers to V = 1/10 and the last to V = ½, for example. The anterior wall of the box carries two hoods projecting rather more than a centimetre's distance, and sufficiently separated to allow the nose to be placed between them. The physician, placed at one side, sees that the eyes remain exposed during the examination. A transposition of the letters is effected by two thin pieces of wood that are attached perpendicularly one over the other, by one of their borders which forms the axis around which they move. One of these pieces, pierced with two lateral holes, gives opportunity for direct vision, the second, which has only a median aperture, is arranged for crossed vision. The openings are provided with weak prisms that facilitate the dissociation of the images, it being sufficient to raise or lower a lever, that is hidden from the person examined, to obtain at will one or the other image by a displacement of the wooden plates. If the patient reads the complete lines he possesses equal visual acuity in the two eyes, the degree of which is indicated by the finest letters which have been read. By taking care in crossing the images, there is opportunity of taking the suspicious malingerer by surprise, who would read only half the line.

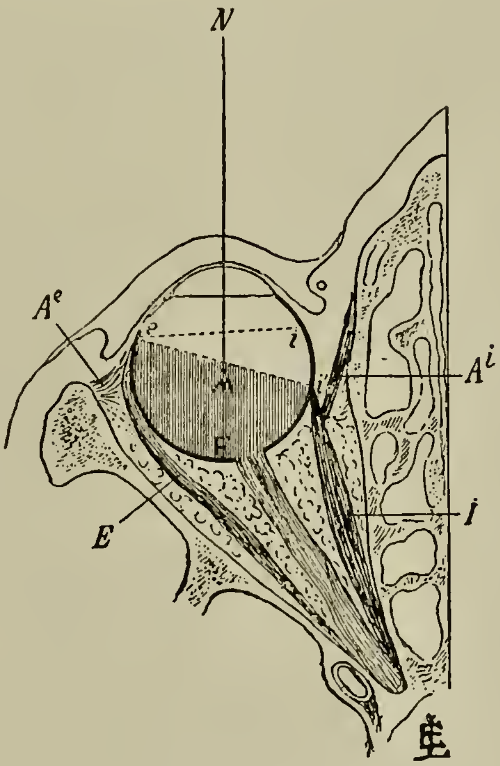
Chaux. (F.) Lime.

Checked clothing, Asthenopia from. Savage believes that an irregular or zigzag contraction of Müller's muscle takes place when hyperopic, astigmatic eyes look at checked cloth or other material similarly treated. The asthenopia resulting from this form of fixation occurs because of the strain upon Müller's muscle whose function it is to sharpen the images in hyperopia and hyperopic astigmatism.

Check ligaments. The excursions of the eye are limited, even in the normal state, by fibrous expansions passing from the tendon of each muscle towards the orbital margin. (See the figure, *AeAi.*) As they become more stretched with the retraction of the muscle, they become veritable *check-tendons,* or *check-ligaments.* This ligament follows the muscle that has been set back, as in the cut, *Ai,* and, even though the muscle may still contract with a certain amount of energy, the ligament neutralizes its effort all the more because the setting back of the muscle has put it on the stretch.

S. E. Whitnall, Demonstrator of Anatomy at Oxford, England, states (*Journal of Anatomy and Physiology,* Vol. 45) the following summary, descriptive of the ligaments and their action:—"The superficial layer of the fascial sheath of the levator palpebræ superioris is very thin over the posterior half of the muscle, but traced forwards is seen to become gradually thicker, until just before the levator expands to form the palpebral aponeurosis, the overlying sheath of connective tissue becomes condensed to form a ligament which stretches transversely across the muscle and extends laterally to the walls of the orbit on either side, to which it has the following attachments: on the inner side the main connection is with the pulley of the superior oblique muscle, but behind this some fibres can be traced directly to the bone, whilst in front of the pulley a well-marked slip of fascia passes forward to bridge across the supraorbital notch, being inserted into the bone at either side of it. Externally, the ligament is fixed to the capsule of the lacrimal gland, and also directly to the bone. The ligament lies free above the aponeurosis for the most part, but laterally a few strands of tissue connect the two.

Anterior to the ligament the sheath becomes so thin as to appear to be wholly absent, but with care it can be traced forwards as a delicate layer of connective tissue passing over the aponeurosis and behind the septum orbitale, to join the periosteum immediately behind the origin of the latter from the supraorbital margin.



Left Eye After Setting Back of the Internal Rectus.
(After Landolt.)

When traction is made upon the levator from behind, the lateral attachments of the ligament are seen to become tense, the upper part of the eyelid comes into contact with the now tightened and transversely disposed band (the intervening roll of fat acting as a buffer to reduce the force of the action), and further backward movement of the upper lid is checked.''

Check-tendons. Another name for the check-ligaments (q. v.).

Cheesy cataract. A hypermature cataract that has undergone retrograde alterations, with degeneration of the lens fibres into a cheesy mass.

Chef. (F.) In anatomy, the heads of a muscle; in surgery, the ends of a bandage.

Cheiragon. (L.) A device to guide the hands of the blind in writing.

Chela. (L.) A natural fissure, like that of the eyelids.

Chelerythrin. This is a powerful cardiac poison, an alkaloid obtained from *Chelidonium majus* (q. v.) and *Sanguinaria canadensis*—blood-root. It occurs as colorless crystals, soluble in alcohol and ether. Doses of .06—1.2 grams of blood-root have produced palpitation of the heart, vertigo, and defective vision.

Chelidonium majus. (L.) CELANDINE. TETTERWORT. A perennial herb originally European but introduced into America. Preparations of the root have been applied externally to warts and various cutaneous eruptions; also to corneal opacities. It is a drastic cathartic, a strong local irritant, and a narcotic.

It was also used by the ancients in the treatment of various diseases of the eye. The active principle is a toxic alkali called *chelidonin.* It occurs as white crystals, insoluble in water but soluble in alcohol and ether. It acts much like morphine, but without increase of reflex action. It is used in medicine in the form of the more soluble hydrochloride, phosphate, sulphate and tannate. Applied locally to the cornea in a 5 per cent. solution it acts as a local anesthetic; the loss of sensibility continuing for ten to fifteen minutes. The application is quite painful, but the pupil is not affected.

Chelius, Franz von. Son of the celebrated surgeon, Maximilian Joseph Chelius, and himself a surgeon and ophthalmologist of some repute. He was born Sept. 6, 1822. In 1873 he became professor of surgery at Heidelberg, soon removed to Dresden, and, in 1877, returned to Heidelberg. He was a very skilful operator in nearly every branch of surgery. He it was who introduced Symes's operation to continental Europe. His articles on this subject were *"De Amputatione in Articulo Pedis"* (Heidelberg, 1846) and *"Uber die Amputation am Fussgelenk"* (Heidelberg, 1846). He wrote a number of ophthalmologic articles, the chief of which was *"Uber das Staphylom der Hornhaut"* (Heidelberg, 1847). He died at Ahrweiler, June 6, 1899. —(T. H. S.)

Chemical cauterants. CAUSTICS. ESCHAROTICS. These are important and valuable agents in the treatment of ophthalmic diseases, their principal value consisting in their power to destroy microbic deposits in *corneal ulcers.* Altogether they form a long list that includes glacial acetic acid, chromic acid, dichloracetic acid, hydric chloride, iodic acid, lactic acid, monochloracetic acid, nitric acid, trichloracetic acid, gold carbolate and paraiodophenol.

Iodized carbolic acid or solution of iodine in glycerine-carbolic acid, is a preparation made from iodine 20 parts, phenol 60 parts and glycerine 20 parts. Applied pure to corneal ulcers it is one of the most effective cauterants and germicides we possess. It is believed to be in that respect even better than pure tincture of iodine or pure phenol used alone. Of course, it is to be carefully rubbed into the stained, cleansed and cocainized cornea by means of a pointed tooth-pick or wooden match soaked in the fluid.

Carbolic acid is one of the most effective germicides in the pharmacopeia. The editor regards a 95 per cent. mixture with glycerine as a good cautery for non-serpiginous ulcers of the cornea. After staining, irrigating and anesthetizing the globe the diseased area should be thoroughly probed with the point of a wooden tooth-pick saturated (not merely dipped) in the solution, excessive fluid being removed from the tooth-pick with blotting paper. This procedure may be repeated several times if necessary. Inasmuch as the phenol whitens the ulcer area it is easy to regulate the application. Success depends upon using as little as possible of the cauterant and tattooing it well into the infected spot. There is little or no destruction of true corneal substance by the carbolic acid and, consequently, a minimum amount of scarring.

I have also found corrosive sublimate a useful application to corneal ulcers in a one per cent. alcoholic solution. Stronger mixtures form efficient escharotics.

Some of the important ophthalmic *caustics* are copper salts, nitric acid, fused potash, silver salts, sodium ethylate, chloride of zinc, ''Vienna paste'' and so-called ''London paste,'' made of equal parts of caustic soda and unslacked lime. For Vienna paste take caustic potash 5, slacked lime 6 parts and make a paste with alcohol.

Escharotics are agents that applied to the tissues destroy them and produce a slough or eschar. A useful escharotic is zinc chloride paste, sometimes employed for the removal of epitheliomata, tubercular growths, warts and other superficial tumors of the lid-skin.

Chemical focus. The point at which the luminous rays of greatest chemical intensity (i. e., the violet rays) are brought together by a simple lens.

Chemical microscope. A compound microscope, the objective of which is placed below the stage, while the rays are diverted upwards by means of a four-faced prism.

Chemical substances, Injuries by. See **Injuries of the eye.**

Chemi-luminescence. Emission of cold light (q. v.), accompanied by chemical changes.

Chemiotherapy, Ocular. See **Blue glass cure.**

Chemischer Brennpunkt. (G.) Actinic focus.

Chemosis. (L.) f. n. Passive or inflammatory edematous infiltration or swelling of the ocular conjunctiva, generally due to infection of the latter. In marked cases the cornea appears at the bottom of a cavity formed by a ring of swollen conjunctiva.

Chemosis blenorrheica. (L.) Chemosis due to gonorrhea.

Chemosis hematica. (L.) Chemosis from an infiltration of blood into the conjunctiva.

Chemosis serosa. (L.) A transparent swelling of the ocular conjunctiva.

Chemotassi. (It.) CHEMOTAXIS. The migration of white corpuscles and other phagocytic material towards a focus of inflammation.

Chémotaxie. (F.) See **Chemotaxis.**

Chemotaxis. The migration of white corpuscles and other phagocytic material towards the focus of inflammation. This active movement of relief agents is excited by the irritation of the toxic substances which originally gave rise to the inflammatory processes.

Chêne. (F.) Oak.

Chenille. (F.) Caterpillar.

Chenopodium hybridum. Both this plant and *Chenopodium ambrosioïdes* (American wormseed; Mexican tea; Spanish tea; Jerusalem tea; Ambrosia) have produced eye symptoms—notably temporary blindness and mydriasis. The etheral oil from *Chenopodium anthelminticum* has also brought on headache and dilation of the pupil among other nervous symptoms. All these remedies are used as nervines and anthelmintics, in doses of from 15 to 60 grains.

Chenu, -ue. (F.) Gray-headed; hoary.

Cheratectasia. (It.) Defect of the cornea.

Cheratite. (It.) Keratitis.

Cheratite con formazione di bolle. (It.) Keratitis with formation of vesicles or bullæ.

Cheratite con ipopion. (It.) Keratitis with hypopion.

Cheratite nell'iridociclite. (It.) Keratitis associated with iridocyclitis.

Cheratite proveniente dalla parete posteriore della cornea. (It.) Keratitis starting the posterior layers of the cornea.

Cheratite punteggiata. (It.) Punctate keratitis.

Cheratite sclerotizzante. (It.) Sclerosing keratitis.

Cheratonissi. (It.) Cheratonyxis.

Cheratoscopia. (It.) Skiascopy.

Cheratoscopio. (It.) Skiascopy or keratoscopy.

Chercheur. (F.) In optics, a finder.

Cherry laurel. The leaves of *Prunus laurocerasus* is the part used in medicine. They contain 1.3 per cent. of laurocerasin. When the leaves are distilled in the making of cherry-laurel water the distillate should contain about one-tenth of one per cent. of hydrocyanic acid. It has an agreeable odor of prussic acid and in ophthalmic therapy is almost entirely used as a vehicle for the exhibition of other agents. It is almost exactly like bitter almond water (q. v.).

Brenzeain (q. v.), made by the action of anhydrous hydrocyanic acid on choral, has been used as a substitute for cherry-laurel or bitter almond water owing to its exact dosage. One part dissolved in 160 parts of distilled water makes bitter-almond water of the same strength of the P. G. The only question that arises is whether in collyria it is as free from irritating effects upon the eye as the best examples of this vehicle.

Cherry-red spot in the macula. In a sudden blocking of the central artery of the retina there is formed at the macula lutea (fovea centralis) a deep-red spot which closely resembles a recent, round hemorrhage in the center of a milk-white area. This is the well-known *cherry-red spot* due to the striking contrast between the red pigment of the choroid and the whitened, thickened retina. It is quite rare to have an embolism of the main branch of the artery without this characteristic red spot, although the latter may be absent in obstruction of the small branches. In the colored race it is seen as a *coal-black* spot.

Cheselden, William. An English anatomist and ophthalmologist, immortal as the inventor of the artificial pupil. Born in 1688 at Burrow, Leicestershire, England, he died at Bath, April 10, 1752. At the age of 15 he began the study of medicine in the house of the celebrated anatomist, Cowper. At the age of 23 he was teaching anatomy. He became successively surgeon to St. Thomas' Hospital, body physician to the Queen and fellow of the Academy of Surgery at Paris. He was one of the trustees of the Barber-Surgeon's Company, just before the mutual separation of the surgeons and the barbers. His skill as an operator was absolutely marvelous, and the greatest surgeons of the world flocked to London to witness his performances. A French physician returned with the tale that he had actually beheld Cheselden perform the urinary calculus operation, complete, in exactly 54 seconds. Rapidity, of course, was a matter of immense importance in the days prior to anesthesia.

Cheselden's works are: *"The Anatomy of the Human Body"* (London, 1713); *"Treatise on the High Operation for Stone"*

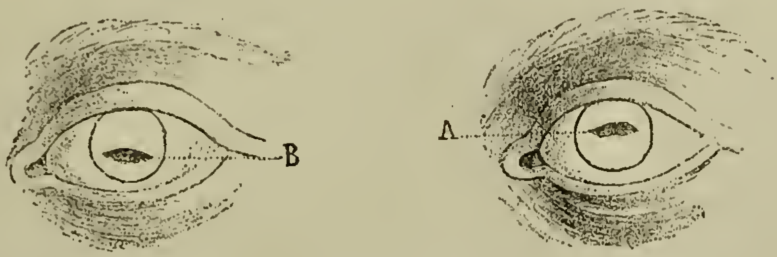
(London, 1723); *"Osteography, or Anatomy of the Bones"* (London, 1733).

Cheselden's most important legacy to all after-coming days is, beyond all question, his artificial pupil. His account of the operation was delivered to the world *via* the *Philosophical Transactions,* vol. xxxv (for 1727 and 1728), London, 1729. The article, which begins on p. 451, is entitled *"An Explication of the Instruments Used in a New Operation on the Eyes* [by Mr. W. M. Cheselden, F. R. S., Surgeon to her Majesty and to St. Thomas Hospital]."

Painted by Richardson, & Engraved by Ridley

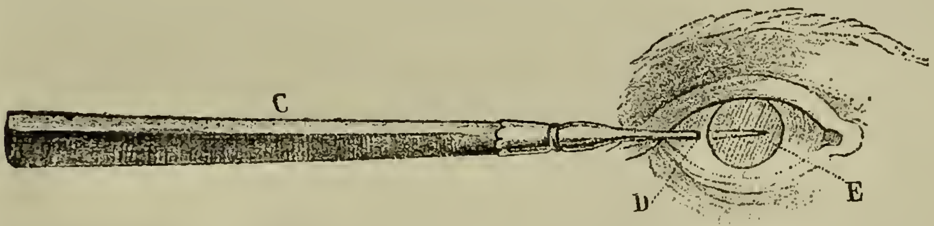
William Cheselden.

Then come some of the most important words and illustrations in ophthalmologic history: "A. B. Represent the figures of two Eyes on which a new Operation was perform'd by making an Incision thro' the Iris, which had contracted itself in both Cases in Such a way as to leave no Pupil open for the Admission of Light.



Illustrations from Cheselden's Book, Showing the First Artificial Pupils Ever Formed.

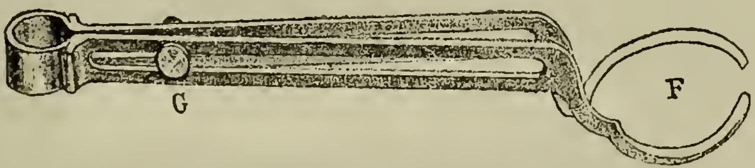
"The Perforation in the Eye A was made a little above the pupil, the closing of which ensued upon the putting down a cataract, which not knowing how low it might be lodged, I made incision a little higher than the middle, lest any part of it should lie in the way.



Cheselden's Iridotomy Needle, and the Way in Which It was Used. His Own Illustration.

"The Eye B was one I couched not long before, where the patient had been blind but a few years. . . .

"C is a sort of needle with an edge on one side, which, being passed through the Tunica Sclerotis, is then brought forwards through the iris a little farther than E. This done, I turn the edge of the needle and cut through the iris as I draw it out: the handle of this needle is half black and half white, which, though it is not of much use in this operation, it is very much so in couching needles, we being thereby able to judge of their position, when we do not see them.



Cheselden's Eye-Speculum. His Own Illustration.

"F is an instrument to keep open the eyelids. G is a bit of iron which, as it is moved backwards or forwards, opens and closes the instrument."

In the Appendix to the fourth edition of Cheselden's "Anatomy" (1730) occurs the following passage, which is also of interest in the present connection:

"Three figures of eyes to explain an operation, which I invented some years ago, and printed a short account of in the Philosophical Transactions, and have often practiced with success. The distemper for which the operation is performed, is either a total closure of the pupil, which is sometimes natural, and sometimes happens from inflammations; or else where the pupil is extremely contracted, and the inner edges of the iris growing to a cataract, or part of a cataract after couching.* The manner of doing this operation is thus: The eye-lid being firmly held open by an instrument, a small knife or needle, edged on one side, is thrust thro the Tunica Sclerotis, as in the lower figure; and then forwards through the Iris, the edge being turned to the Iris; in drawing of it out, a slit is cut as in the two upper figures. When this distemper is without a cataract, it is best to make the operation in the middle, as in the upper one; but if there is a cataract, or part of a cataract, then to make it higher that the cataract may not obstruct the light. These cataracts are generally very small, and sometimes by reason of their adhesion not to be removed. The aperture in the middle eye, was made lower than the center of the Cornea, there being an Albugo on the upper part of it, which made it unfit to perform the operation in that part."

In the 5th edition of the same work occurs, further, the following passage, by way of explanation to a figure: "A knife, passed through the Tunica Sclerotis, under the cornea before the iris, in order to cut an artificial pupil, where the natural one is closed. This operation I have performed several times with good success; indeed it cannot fail, when the operation is well done and the eye not otherwise diseased, which is more than can be said for couching cataract. In the operation great care must be taken, to hold open the eyelids without pressing upon the ball; for if the aqueous humor is squeezed out, before the incision is made in the iris, the eye grows flaccid and renders the operation difficult."

It will, of course, have been observed that what Cheselden really did was not to remove a piece of the iris, but merely to incise that structure, relying on the contraction of the radiating fibres to pull the incision open. In other words, he performed not an iridectomy, but an iridotomy. However, he did not call his operation by the polysyllabic Greek term, but only by the English non-technical expression, "incision thro' the iris." The expression, Iridotomia, Iridectomia, and Iridodialysis, we owe to Dr. Karl Wilhelm Ulrich Wagner, who, in 1818, first employed them in his *"Commentatio de Coremorphosi."* The operation of iridectomy we owe to Joseph Beer, of Vienna, who first carried out the procedure in 1798, publishing an account thereof in 1805.

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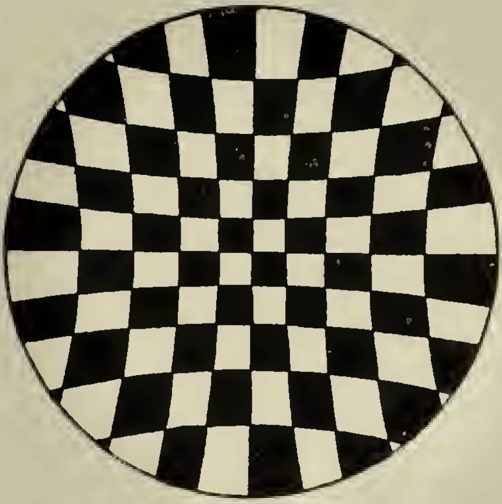
* There was no extraction of cataract in those days.

Cheselden's great invention, when viewed from a certain angle (that, namely, of our modern vantage ground) appears to have been not only an extremely simple affair, but also one of no very great importance, seeing that it has long ago been relegated to oblivion. Yet we need to remember that the simple procedure in question constituted, as it were, a point of departure for a long series of inventions, many of which may perhaps endure as long as ophthalmology itself.—(T. H. S.)

Chess-board of Helmholtz. The so-called hyperbolic chess-board of Helmholtz is a well-known optic device, which is reproduced here in the proportion of 3:16. As Tscherning (*Physiological Optics,* p. 216) says, Helmholtz found that, placed at a distance of 20 centimeters, for which the chess-board was calculated, he saw the curves assume the appearance of straight lines when he fixed the middle of the drawing. When he stood at a greater distance, the lines appeared to have the curvature which they really had; moving nearer and nearer, he saw the curvature diminish and finally completely disap-



Hyperbolic Chess-Board of Helmholtz.

pear. The distance at which the curvature disappeared was each time almost exactly 20 centimeters. If he approached nearer still, the lines presented the reverse curvature, appearing concave towards the middle. The great observer consequently concluded that in indirect vision the eye is not rectilinear. Tscherning, however, believed these deformities to depend first of all upon the form of the retina. Projecting a plane on a hollow sphere, we necessarily obtain towards the periphery a narrowing of the projection analogous to that which we have found for the eye. It is possible, however, that the position of the pupil in front of the nodal point may play a certain part.

Cheval. (F.) Horse.

Chevelu. (F.) Hairy.

Chèvre. (F.) Goat.

Chevreul, Michel Eugène (1786-1889), French chemist, born at Angers, lectured at the Collège Charlemagne, and was appointed special professor of chemistry in charge of the dyeing department at the Gobelins. In 1826 he took his seat in the Academy of Sciences, and in 1830 became director of the Museum of Natural History. One of his earliest discoveries was that of margarine, oleine, and stearine in oils and fats. Between the years 1828 and 1864 Chevreul studied colors, publishing important memoirs from time to time. In 1886 the hundredth anniversary of his birth was celebrated with great enthusiasm. He published works on dyeing and histories of chemical science, and of theories of matter. His *De la Baguette divinatoire, du Pendule explorateur et des Tables tournantes* is the best book on the subjects of which it treats.

Chevrotant. (F.) Quivering; tremulous.

Cheyne-Stokes nystagmus. A form of nystagmus in which the globe exhibits rhythmic movements similar to those of the chest-walls in Cheyne-Stokes respiration.

Chiaroscuro. (It.) An artistic term signifying *the art of representing light in shadow and shadow in light,* so that the parts represented in shadow shall still have the clearance and warmth of those in light, and those in light the depth and softness of those in shadow. The skillful treatment of chiaroscuro is a matter of extreme difficulty; yet it is a branch of art without the mastery of which no painting can be successful in any deparment. It is as indispensable in portrait-painting as in the highest department of ideal arts. The only mode by which a knowledge of chiaroscuro can be attained, so as to apply it to practice, is by studying it as exhibited in the works of such painters as Titian, Rubens, Rembrandt, and Correggio.

Chiaroscuro is a term also applied to an early method of printing wood-engravings from several blocks, and also to a picture in black and white, or brown and white only.

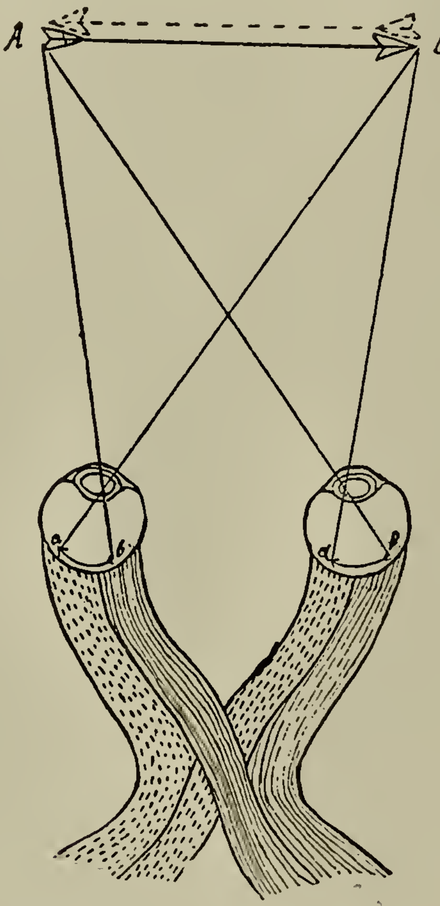
Chiasma. Optic commissure. Optic chiasm. The chiasm is an important portion of the intracranial optic nervous system and is formed by a decussation of the two optic tracts in front of the tuber cinereum. The decussation is said to be complete in most animals, but in man some of the fibres of each tract do not cross over and are not continuous with the opposite optic nerve; they either enter the opposite tract or pass along and are continuous with the nerve fibres of the same side.

M. Marquez (*Archivos de Oftal. Hispan.-American*, March, 1901, translated by Frank Ring for the *Annals of Ophthalmology*, 1904, p. 548) gives an interesting historical note regarding the anatomy and physiology of the chiasm.

The old and much disputed question of the inter-crossing of the optic fibres has been definitely determined by the investigations of Cajal. The older authors, however, gave the most diverse opinions as to the crossing of the optic nerves. They asserted: 1st. The optic nerves do not cross. (Galen, Vesalius, Maitre-Jean, Demours, Jr., etc.); 2nd. The optic nerves inter-cross entirely. (Soemmering, Brisadecki, Mandelstamm, Kölliker, until 1899); 3rd. The optic nerves inter-cross partially. (Newton, Taylor, Wollaston, Müller, Gudden, Cajal).

In reality, the first who formulated the hypothesis of semi-decussation was the physicist and mathematician, Isaac Newton, who published in 1704 the first English edition of his work on optics. He says: "The fibres of the right side of these nerves unite in the chiasm, and they go together to the cerebrum by the nerve which is in the right side of the head, and the fibres which are in the left part of such nerve, unite also in the same place, marching afterward together to the cerebrum through the nerve which is in the left part of the head, so that the two posterior nerves are united in such a manner in the cerebrum that their fibres constitute there a single image, of which the half that is in the right side of the sensorium comes from the right side of the two eyes through the right side of the two optic nerves, and the half which is on the left side of the sensorium proceeds in an analogous manner from the left part of both eyes. Then the optic nerves of those animals which look at the same place with both eyes (like man, dog, sheep, ox) join into one before entering the cerebrum, while the optic nerve of those animals which do not look at the same place with both eyes (like fish and chameleons) do not unite nor mix their fibres, if I am not badly informed."

As may be seen, Newton limits himself to exposing, without demonstrating, the hypothesis, with the sole object of explaining simple vision with the two eyes, admitting that in the said unique image, the half corresponds to one side of the cerebrum and the other half to the other side of the cerebrum. Insomuch as the final paragraph refers to the optic nerves of fishes and chameleons, it is totally inexact.



Chevalier Taylor's Diagram of the Chiasma.

It is true that Newton speaks in this by references, and not in affirmative tones, as some have attributed to him.

The Chevalier Taylor, who lived from 1708 to 1772, in a work entitled, *"The Mechanism, or New Treatise of the Anatomy of the Globe of the Eye,"* printed in Paris in 1738, explains the reason why objects appear straight, although their images are pictured reversed upon the immediate organ of view.

The most important work of Taylor, is that referring to the semidecussation of the optic nerves, and this is elaborated with such a masterful hand that it might appear to have been written at the present time. It is true that the original hypothesis belongs by right to Newton, but the wise English mathematician limited himself to enunciating it, without attempting to demonstrate it, and left, the same as the other questions, to serve as an object of observation and experimentation to other investigators. Besides, Taylor in the chapter which he dedicates, at the end of the work, to Bibliography, cites nothing from the *Optics* of Newton, in spite of the fact that this memorable book must have been then well known in Europe, and with great reason, to Taylor.

After relating the classical experiment of physiologic diplopia, he interprets it in a precise manner, admitting that when the eyes do not fix one object or another situated nearer or farther away, the impressions of each one of the eyes are transmitted by nervous fibres which are not corresponding and in so much as they do not unite in the place that the optic nerves meet in the head. On the contrary, when the two eyes fix an object, the images fall upon points from whence fibres depart, which unite before reaching the common sensorium. The author in his love for similes compares it to the case of a bell, the cord of which is divided in two at its lower extremity, so that two men may ring it at the same time; the bell will ring if either of them pull it, or will do the same if both pull at once. The author concludes: "That there is no communication or sensation between the external parts of the fundus of the globe of one eye, and the extreme parts of the fundus of the globe of the other eye, nor between the internal parts of one eye and those of the other; that solely the middle of the fundus of the globe of one eye (the fovea we call it to-day) corresponds to the fundus of the globe of the other, but there is no correspondence between the external parts of the fundus of the right globe, and the interior of the fundus of the left globe—thus all the points of the left side or exterior of the fundus of the left eye correspond with all the points of the left side or interior of the right eye—each point in one eye with each point in the other which are respectively equidistant from the optic axis and at the same side of it; the same occurs with the fibres of the right side."

Afterward he says: "The fibres of the optic nerve terminating in the left side of the fundus of the globe run in the left side of the optic nerve until they reach the point—in which they unite with those which depart from the left side of the fundus in the right eye—after which they run in a compound nerve in the left side of the cerebrum in which this nerve terminates."

As may be seen, the preceding is the same hypothesis of Newton, but explained in detail, which so far as I know was not done by the author of *Optics* himself, before the publication of Taylor;[*] but there is more yet and that is the graphic demonstration by a proceeding which we might call ad absurdum of this which could not be otherwise explained. Let us take the words of Taylor himself: "In order to see if that which I say is not a simple supposition, I shall demonstrate that there exists a correspondence between the right and left sides of the fundus of the eyes. Let us suppose A B an arrow placed transversely before the eye, only one arrow will be seen as I have already noted, whether viewed with one eye or with both eyes; the image of this arrow in the right eye is in the position of *c, d* inverted with respect to the object, and in the left eye in the position of *a b,* also inverted with respect to the object, and finally in the same position as the right eye. If the extreme parts *a* in the fundus of the left eye communicate with the extreme parts *d* of the fundus of the right eye, and also the internal parts of *b* and *c,* we will see two arrows one at the side of the other, but, inverted one with respect to the other, because then *c* and *d* receiving the impressions of the different extremities of this arrow, and communicating, the same *a* and *b* will give a double sensation of this arrow; but, granting that we see no more than one arrow instead of two, it is necessary that the point *a* of the left eye communicate with the extreme point *c* of the right eye and the internal point *b* of the right eye with the external point *B* of the left eye, and by this means when we see the arrows (or other object) with the two eyes, the arrow is not seen double, but, its sensation will be only stronger."

Now, what is this but the exposition clear and conclusive of the theory of the identical and corresponding points, which are attributed to Johannes Müller, who, as is well known, did not publish his great treatise on physiology, until 1838, that is to say exactly a century after the publication of Taylor's *Mechanism.*

And as regards the rational demonstration cited, there is no other conclusion than the existence of the chiasmatic semi-decussation because without this, diplopia would follow. What is this but an anticipation of what has been so recently demonstrated by Cajal in his notable work upon the chiasm, already quoted therein availing himself of a scheme fundamentally identical with that of Taylor, and employing analogous reasons to reach the same conclusions, which could not be otherwise, since the contrary would always have as a consequence diplopia.

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[*] According to Mackenzie, Vater and Heinicke, in 1723, had explained by the hypothesis of Newton, several cases of hemiopia.

I hasten to add that Cajal, to whom I have shown Taylor's book, had no knowledge of it; but, even if he knew of it, this would not diminish in the least the surpassing merit of the work of our noted histologist because the theory of the chiasmatic inter-decussation, so admirably developed and amplified with proper reasons, is there at least, being in exchange the starting point of an ingenious and original theory as to the inter-decussation of the nervous paths in general (accepted afterward with enthusiasm, by the most eminent neurologists of the world). And this constitutes the principal merit of the work quoted in the speculative as well as in the practical order.

In one point in the demonstration of the total crossing of the optic fibres of the inferior vertebrates, and the existence of the direct fasiculus in man and approximate animals, and in the others, the discovery of the existence of bifurcated fibres, (admitted as proven later by Kölliker) which redeems a very important treatise by explaining the functional relations between the two eyes.''

The optic chiasm rests on the optic groove of the sphenoid bone. Above, it is attached to the brain, and is separated from the third ventricle by a gray membrane, the lamina cinerea. External to the chiasma is an area pierced by a number of small arteries, the anterior perforated spot. Behind it is the posterior perforated spot and a conic membranous process, the infundibulum, connected with the pituitary body. The chiasma consists of the true and the accessory tracts. The true tracts are of two kinds: the crossing fibres from the nasal sides of the retinæ, which occupy the centre, and the uncrossed fibres from the temporal sides of the retinæ, which occupy lateral positions. The fibres originating in the macula lutea have been so carefully traced of late years as to call for the naming of a third class of fibres, the ''macular fascicle.'' Some of these decussate, while others do not. The accessory fibres are those of Meynert and Van Gudden. They are fibres arising from the internal geniculate body of one side, which, passing forward to the optic chiasma, traverse its posterior border, and then bend backward to end in the internal geniculate body of the other side. They play no part in vision. While the commissure of Van Gudden lies within the posterior angle of the chiasma itself, and is only with difficulty differentiated from the decussated optic fibres, the fibres of Meynert are distinctly separated from the chiasma by a thin layer of gray substance. Their course, too, runs parallel to the posterior angle of the chiasma.

Each optic nerve consists of two bundles of fibres: an outer and an inner. The outer, consisting of fibres coming from the outer half of the retina, do not cross, but pass to the same side of the brain; the inner, derived from the inner half of the retina, cross to the opposite side of the cerebrum and end in the pulvinar, anterior quadrigeminate, and external geniculate bodies. Thus, the right pulvinar, right anterior quadrigeminate, and external geniculate bodies receive fibres from the nasal half of the left eye and the temporal half of the right eye. Thus, decussation of the chiasma is not complete, but is a semidecussation. Owing to the manner of crossing, the right halves of both retinæ and the left halves of the visual fields belong to the right optic tract, while the left halves of both retinæ and the right halves of both visual fields belong to the left tract. Objects situated to the left of the observer become known to him by excitation of the right occipital cortex, and vice versâ. The fact of semidecussation of the optic nerves permits the explanation of half-sight—hemianopsia, or hemiopia.—(J. M. B.)

Photomicrograph of the Optic Chiasma, Showing Decussation of the Nerve-fibres. (Ball.)

According to Norris and Oliver (*System of Diseases of the Eye*, Vol. 2, p. 263), if it be supposed that the chiasm be divided by a frontal incision passing in the direction *á eb* of the figure into an anterior and a posterior section the conducting path is destroyed (the *fasciculi laterales* plus the *fasciculus cruciatus* of each hemisphere), causing amaurosis with loss of pupil reflex in both eyes. "In the course of some weeks the descending atrophy that follows the division of the axis-cylinders of the whole nerve-trunk (the centrifugal and centripetal) from their primary centre (the anterior corpora quadrigemina and the corpus geniculatum externum) on the one hand, and the ganglion cells which lie in the ganglion-cell layer of the retina on the other hand, causes the fundus, which is at first quite normal, to present gradually the picture of optic atrophy. In contrast to this, let the chiasm be supposed to be divided by a line in the plane of the sagittal suture, *ced,* into a left and a right half. The conduction path from the inner halves of the retinæ of both eyes (mp and m^1p^2), is completely destroyed. This causes the temporal halves of both fields of vision to be blind, and, in consequence of the interruption in the conductivity of both crossed fasciculi, permanent temporal hemianopsia results. After a few weeks the inner halves of the papillæ and the temporal halves, which are formed of the crossed bundles of nerve-fibres, as well as the papillo-macular system, become whitened in consequence of descending atrophy, leaving the fasciculi non-cruciati intact. The nasal half of the field of vision of each eye remains normal, and the normal color-limits of these halves coincide accurately with the vertical line of separation between the two halves of the field of vision. In such a case of typical hemianopsia caused by a division of the chiasm at its centre by a cut in the plane of the sagittal suture, the blindness of the halves of the field of vision remains stationary, and the nasal halves of the field permanently retain their normal action, partly because the nerve-fibres which are included in the fasciculus non-cruciatus are not separated from their ganglion-cells, and partly because the supply of their nourishment is in no way disturbed. Heubner and Duret assert that each half of the chiasm, exactly to the middle line, is supplied from the basal artery of the brain of the corresponding side, and especially from the two anterior cerebral

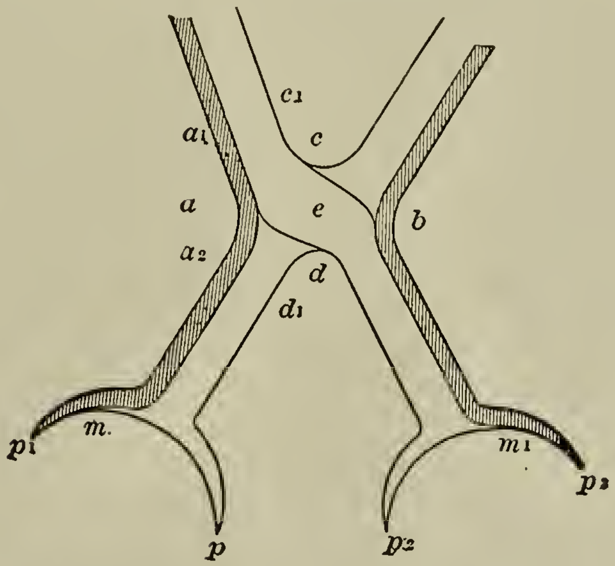

Diagram to Show the Effect of Injuries and Diseases of the Optic Nerve. (After Norris and Oliver.)

arteries. The internal carotids on both sides send several twigs to the sides of the chiasm, and the posterior communicating arteries also, in less degree, contribute to the blood-vessels of the posterior portion of the chiasm.''

One of the most important monographs on this subject is the Kölliker (*Festschrift Ueber Sehnerven-Degeneration und Sehnerven-Kreuzung,* Wiesbaden, 1887) edited by von Michel in which the crossed and uncrossed fibres of the chiasma are considered and pictured from original preparations of man and the lower animals.

Diseases of the optic commissure will be further considered mostly under the headings **Field of vision** and **Hemianopsia**, but it may be said here that visual disturbances resulting from affections of the chiasm are mostly due to acromegaly, tumor of the pituitary body, tubercle and syphilitic gummata. For example, the symptoms *temporal hemianopsia,* as one of the signs of chiasma involvement, was found by Cell (*Chiasmaerkrankungen. Inaugural Dissertation,* Leipzig, 1894, p. 2.) to result from the following: seven cases by trauma, twenty-five by tumors, six by tuberculous exudations or granulations, four by aneurisms, two by pressure from the third ventricle, two by periostitis, four by partial meningitis, sixteen by basilar gummatous meningitis and syphilitic disease of the chiasm, one by gummatous arteritis, one by hemorrhages into the chiasm, one by multiple sclerosis and one by the hyperplasia of elephantiasis. See, also, **Acromegaly**; and **Hypophysis, Diseases and tumors of the.**

Chiasmal amblyopia. There are some forms of central scotomata which furnish early signs of disease of the chiasma, but which are with difficulty distinguished from those of ordinary toxic amblyopia. Nettleship believes that these defects in the center of the field are more abruptly defined than in toxic amblyopia, both as to degree and time. It is possible that chiasmal amblyopia may be caused by disease of the pituitary body.

Chiasmal field. In *physiologic optics,* the vertical cross-section, parallel to the interpupillary distance, through the center of the optic commissure. See also **Chiasmal image.**—(C. F. P.)

Chiasmal horizon. In *physiologic optics,* the horizontal diameter of the chiasmal field in whose center are located the superposed chiasmal images transmitted from the macular centers, the foveæ of both eyes. See also **Chiasmal image.**—(C. F. P.)

Chiasmal image. In *physiologic optics,* a strictly figurative image consisting of that orderly assemblage of the optic-nerve fibrils, within the cross-sectional and comparatively small area of the optic chiasm, which receive their individual stimuli from corresponding points in each retinal image. Of course, this also implies that the supposed chiasmal image should be proportionately smaller than the retinal images, in order that they may appear in their entirety within the more circumscribed area of the chiasm. However, this may remain a matter of conjecture, and is quite immaterial, when merely comparing the positions of the images projected from the retinæ into the parallel area of the optic commissure, and that may or may not there constitute a *single* chiasmal image of the size conceived by the brain in either orthophoric (orthoscopic) or heterophoric vision, respectively. With this conception of the chiasmal image, orthoscopic binocular vision may be said to require absolute equality in the dimensions of the retinal images, in order that these identical images, when conveyed by the optic nerve, may exactly cover each other at the optic chiasm. In other words, the axial image-points m and m_1, Fig. 1, being separately transmitted by their respective optic-nerve fibrils, must exactly cover each other at the center C of the chiasmal image, which is, therefore, of two-fold light and shade intensity, provided that the light and color perceptions, respectively, are the same for each eye. In Fig. 1 this increased intensity of the chiasmal image at C is graphically illustrated, being achieved in the drawing through superposition of the vertical and horizontal shadings used respectively to distinguish the right and left retinal images in R and L from each other.

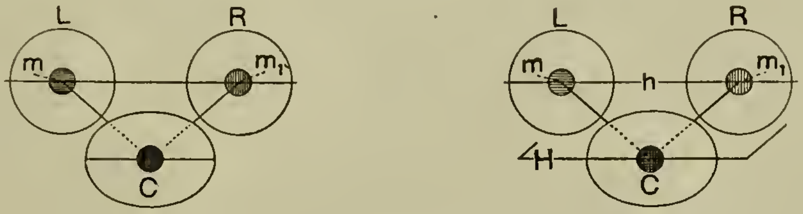

Fig. 1. Fig. 2.

Chiasmal Image.

This single chiasmal image at C corresponds to that equipoise of the extrinsic ocular muscle which is associated with the normal directions of both visual axes, called orthophoria. In fact, it is that condition in which the centers m, m_1 and C of their respective images are all located in the same horizontal plane hH, thereby insuring a common horizon for them as shown in Fig. 2. Therefore, the *chiasmal horizon,* in the absence of a better term, may be said to be the horizontal diameter of the chiasmal field in whose center C are located the superposed chiasmal images transmitted from the macular centers m and m_1, the foveæ of both eyes. In fact, as will be later shown, the axial image-points m and m_1, the centers of the maculæ, are always projected to the center of the chiasmal field C, regardless of the directions of the visual axes. It is evident that a faulty projection of the visual axes, such as in hyperphoria, for instance, will cause a change in the elevation of at least one of the axial image-points, m, m_1, with respect to a common horizon H, thus creating two vertically displaced images of the same object somewhere within the field of the optic chiasm.

In order to become familiar with the location of such dual chiasmal images it is necessary first to determine the positions of their corresponding retinal images. A fundamental law in physiologic optics teaches that the center of the object and the center of the image are in line with the nodal-points of the eye; in other words, the center of the object, the nodal points and the macular center are points upon the same line, the visual axis, located in a plane coincident with, or that may be inclined to, the horizon. In the following diagrams the single nodal point of Donders' reduced eye is applied.

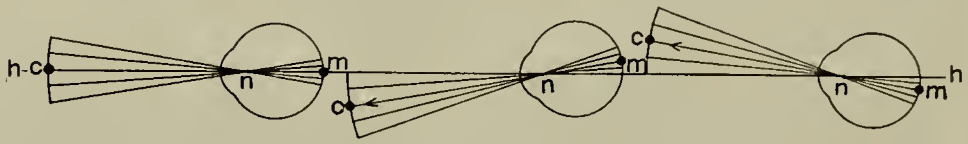

Fig. 3. Fig. 4. Fig. 5.

Chiasmal Image.

In Fig. 3, the visual axis cm is coincident with the horizontal plane hh. In Fig. 4, the visual axis cm is directed below, whereas, in Fig. 5 it is directed above the horizontal plane hh.

In each of these figures the visual axis is directed to the center c of its own object-space, irrespective of the dimensions of the object that may be located upon the horizon, so that the visual axis may also be said to be a line connecting the center c of the object-space with the center m of the image-space. Therefore, each change in the direction of the visual axis merely establishes a new center c in the object-space of the deviating eye which is in line with the fovea m, the center of the image-space.

In short, for the deviating eye, Fig. 7, D is the displacement of the visual axis cm_1 from the object-center O, whereas d is the corresponding displacement of the fovea m_1, from the image-center I_1.

It is here proposed to confine the discussion to hyperphoria, because it may be more effectually counteracted through the use of prisms than any other muscular imbalance. For convenience, the left eye, Fig. 6, is pictured from the temporal side with its visual axis cm horizontal; therefore, the centers of the object O and its retinal image I

are located in the plane of the horizon. The right eye is shown in Fig. 7, from the nasal side, with its visual axis cm_1 in the object-space below the horizon; wherefore, the center of the same object O is above the visual axis cm_1, and the center of the image I_1 is correspondingly below it at a distance d from the fovea m_1. Comparison of the figures shows that the centers of the retinal images I and I_1, in both eyes are located in the same horizontal plane hh, but that they occupy quite different positions with respect to their associated axial image-points, m and m_1. The fovea m of the left eye and the center of its retinal image I are coincident, whereas, in the right eye its retinal image-center I_1 is below the fovea m_1. Moreover, it is quite evident that there would *not* be any consciousness of a difference in the elevations of the retinal images, I and I_1, if they were transmitted by the optic nerves to the chiasm in the same horizontal plane hH, as shown in the *incorrect* Fig. 8.

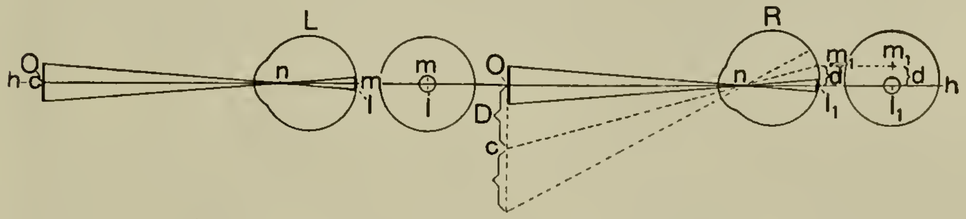

Fig. 6. Fig. 7.

Chiasmal Image.

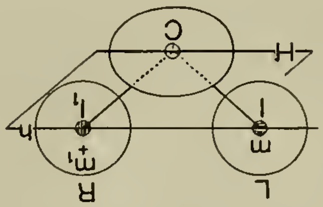

Fig. 8.

Chiasmal Image.

That two images are produced which effect consciousness of a difference in their elevations with respect to a common horizon H is proof that the phenomenon must be explained through the associated functions of the optic nerves and the chiasm. In fact, this consciousness of two images can only be accounted for by the assumption that the *axial image-point of each eye at the macula is conveyed by its corres-*

ponding optic-nerve fibril to the center of the chiasmal field. In other words, *both macular centers m and m_1 are transmited by their respective nerve fibrils so as to produce superposed images of themselves at the center C of the chiasm,* Fig. 9, regardless of any deviation that may exist between the visual axes.

Such being the case, the center m of the retinal image I, when transmitted through the *left* optic nerve by its macular fibril mC, Fig. 10, is located in the center C of the chiasm upon the chiasmal horizon HH; whereas, the center I_1 of the retinal image in the right eye is conveyed along the right optic nerve below the macular fibril of m_1 to a point at the same distance d below the chiasmal center C. In short, the vertical separation of the chiasmal image-centers is equal to the distance d between the macular center m_1 and the center I_1 of the image in the deviating eye.

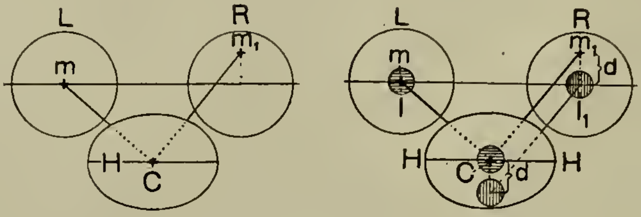

Fig. 9. Fig. 10.

Chiasmal Image.

It is further evident that, if the vertical displacement d of the fovea m_1 in the deviating eye is greater than or equal to the diameter of the retinal image itself, two *separated* chiasmal images are formed, Fig. 11 and Fig. 12; whereas, if the displacement of the fovea m_1 in the devi-

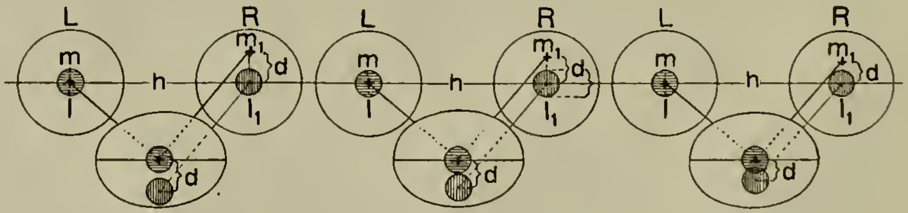

Fig. 11. Fig. 12. Fig. 13.

Chiasmal Image.

ating eye is *less* than the diameter of its retinal image, two excentrically superposed chiasmal images are produced, Fig. 13. Therefore, the nature of these dual images, as to whether they are separated or overlap, depends upon the proportion of the displacement d of the fovea m_1 in the deviating eye to the diameter of its retinal image I_1 centered in the horizontal plane h.

Moreover, the foveal displacement d and the diameter of the retinal image may both be determined, provided the distance of the nodal point from the retina is known. For example, Donders' reduced eye being chosen, and in which the distance between the nodal point and the retina is equal to 15 mm., or 1.5 cm., it is apparent from Fig. 14

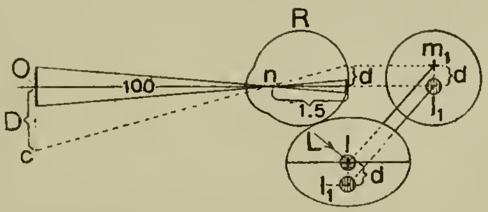

Fig. 14.

Chiasmal Image.

that: $\frac{d}{1.5}=\frac{D}{100}\ \therefore\ d=\frac{1.5D}{100}$, in which D is a dimension in the tangent plane Oc at a distance of 100 cm. from the nodal point n. Therefore, D is synonymous with the prism-dioptry when it is made equal to 1 cm., and, if introduced in the above equation, gives $d=\frac{1.5}{100}=0.015$ cm., or 0.15 mm. as the separation of the chiasmal image-centers for a deviation of the visual axes corresponding to 1 △ prism-dioptry. The above equation also proves that:

In manifest hyperphoria of 1 prism-dioptry the distance between the chiasmal image-center is equal to the one-hundredth part of the distance between the nodal point and the retina in the deviating eye. It is also apparent that the separation of the chiasmal image-centers will increase in proportion to the deviation between the visual axes, wherefore, 1△ 2△ 3△ 4△ of deviation between the visual axes correspondingly produce 0.15 0.3 0.45 0.6 mm. separation of the chiasmal image-centers. It is next necessary to determine the size of the retinal images, in order to ascertain if the chiasmal images are separated or overlap for a particular deviation of the visual axes. As the size of the retinal image depends upon the size of the object, it is convenient to select as the object one of the small letters that represent the conventional unit of visual acuity in Snellen's test types, and whose vertical and horizontal dimensions are embraced by the visual angle of 5 minutes. Therefore, the height of this object corresponds to the tangent of 5′, which, if computed at a distance of 1 meter, is 0.001455 M., or 1.455 mm.; consequently, the object-letter is 8.73 mm. square, at 6 meters, the distance at which the type is used. Incidentally it may be stated that this dimension is rarely exactly reproduced in modern editions of Test Types, and which are often found to be correspondingly faulty in all of the letters. The size of the retinal image, I, produced by a letter 8.73 mm. square, when placed at 6 meters from the reduced eye, may be deduced from Fig. 15 as follows: $\frac{I}{15} = \frac{8.73}{6000} \therefore I = \frac{15\text{x}8.73}{6000} = 0.02182$ mm., which indeed is such a minute dimension that, even if mechanically reproduced for inspection, it could scarcely be differentiated by the eye without the use of a microscope.

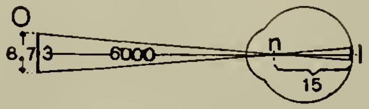

Fig. 15.

Chiasmal Image.

As $1^{\triangle}$ is known to produce a separation of the chiasmal image-centers equal to 0.15 mm., and the vertical dimension of the retinal image in the deviating eye of normal visual acuity is 0.02182 mm., it follows that the dual chiasmal images are *separated*, since d $= 0.15$ mm. is greater than I or $I_1 = 0.02182$ mm.

In order that the dual chiasmal images may just touch each other peripherally, the diameter of the image I would have to be equal to d $= 0.15$ mm. This value for I being introduced in the equation $\frac{O}{I} = \frac{6000}{15}$ gives the diameter of the object $O = \frac{0.15\text{x}6000}{15} = 60$ mm., which is also the value of the prism-dioptry at 6 meters distance.

VISUAL ANGLE 5′

Distance		Height
60 M.	**E**	87.3 mm.
		60 mm.
36 M.	**T**	52.38 mm.
24 M.	**D**	34.92 mm.
18 M.	**P**	26.19 mm.
12 M.	**F**	17.46 mm.
9 M.	**O**	13.095 mm.
6 M.	**L**	8.73 mm.
1 M.	**H**	1.455 mm.
⅓ M.	**v**	0.485 mm.

Reference to the adjoining chart of letters shows that 60 mm. is the dimension of a letter which should be interpolated between *E* and *T*. In other words, all of the letters between *T* and *L*, when viewed at a distance of 6 meters, produce *separated* chiasmal images for a manifest hyperphoria of 1^{Δ}; whereas, letters or objects which are larger than 60 mm. in height will produce vertically overlapped chiasmal images whose centers are uniformly 0.15 mm. apart.

Separated chiasmal images also apply to type held at the reading distance whenever the letters are smaller than the prism-dioptral deviation between the visual axes in the object-space. For instance, in the accompanying chart the letter *v* is 0.485 mm. high at ⅓ M., whereas the prism-dioptral deviation at this distance is ⅓ of a centimeter, or 3.33 mm. This deviation, being considerably greater than the vertical dimension of the letter *v* in the object-space, will naturally cause visual confusion, through making a printed line of the same kind of type appear to be projected from the position of the line next following when the consecutive lines of type are 3.33 mm. apart. For this reason hyperphoric subjects of 1^{Δ}, even with normal retinal perception in each eye, can not read very small type, nor without great difficulty even ordinary type, and frequently complain of a sense of uncertainty in following the lines of a printed page.

The limits between which *overlapped* images are produced is made apparent in the following necessarily exaggerated diagrams, in which the dimensions of the various retinal images have been calculated for white square targets of different sizes placed at 6 meters distance. In Fig. 16 the retinal images are 0.15 mm. square, which, being equal to the foveal displacement corresponding to 1^{Δ}, not only shows the chiasmal images to be peripherally in contact, but also that the chiasmal image for the left eye is extended below its horizon by an amount equal to the height of the chiasmal image for the right eye, thus producing a vertically elongated picture of the square target that is twice the height of the normal image conceived in orthoscopic binocular vision.

DEVIATION BETWEEN THE VISUAL AXES=1 PRISM-DIOPTRY.

Foveal Displacement, Separation of the Chiasmal Image-Centers and the Image-Extension=d=0.15 mm.

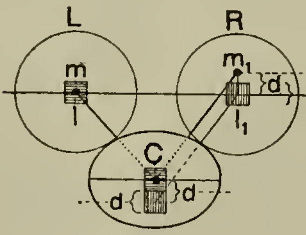

Fig. 16.

Object, 60 mm. sq.
Image, 0.15 mm. sq.

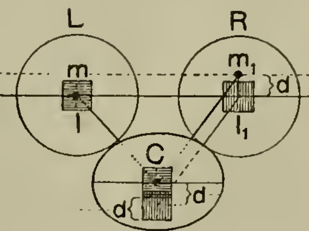

Fig. 17.

Object, 87.3 mm. sq.
Image, 0.2185 mm. sq.

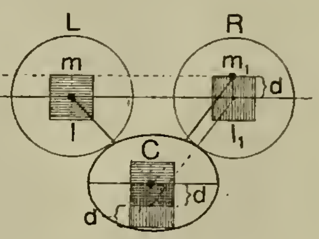

Fig. 18.

Object, 120 mm. sq.
Image, 0.3 mm. sq.

The retinal image in Fig. 17 is 0.2185 mm. square, and being larger than the foveal displacement, shows the chiasmal images to overlap. In fact, as the retinal images proportionately increase in size for the larger objects placed at a fixed distance, so will the chiasmal images increase and invade each other vertically from their respective fixed centers. Fig. 18 represents a still larger image, 0.3 mm. square, demonstrating that the chiasmal images overlap each other by one-half. Furthermore, in all of these diagrams it is made apparent that the foveal displacement, the separation of the chiasmal image-centers and the extension of the normal image are one and the same linear dimension. Therefore, it has been conclusively demonstrated that for each prism-dioptry of deviation between the visual axes there is a separation of the dual chiasmal image-centers equal to 0.15 mm.; that the chiasmal images are *separated* when the retinal images are smaller than the foveal displacement, and that the images overlap when their retinal images are larger than the foveal displacement in the deviating eye. Recalling that the prism-dioptral deviation between the visual axes in the object-space bears the same proportion to the size of the object itself as the foveal displacement to the retinal image in the deviating eye, it is also to be understood that the chiasmal images are vertically separated when the size of the object viewed binocularly is less than the prism-dioptral deviation, and that they overlap when the object viewed is greater than the prism-dioptral deviation between the visual axes.*

Familiarity with the principles herein set forth should not only impress the ophthalmic surgeon with the extreme delicacy of the muscular balance necessary to maintain orthoscopic binocular vision, but also encourage him to make effort to counteract minor degrees of hyperphoria through optical rather than by surgical means; especially when it is emphasized that the displacement of the fovea in the deviating eye amounts only to 0.6 of a millimeter for a deviation between the visual axes of 4 prism-dioptries, commonly thought to be effectually corrigible through the application of surgical skill, and which it is conceded bespeaks marvelous dexterity where it has been successfully applied in cases of this kind.—(C. F. P.)

Chiastometer. An instrument devised by Landolt for determining the distance between the two eyes during the act of convergence [and for determining the degree of deviation of the optical axes from parallelism]. It consists of a long rectangular box lined with black, unreflecting material, and provided with a cover. At one end are two short tubes for the reception of the eyes, the margins of which are applied to the inner margins of the orbits. There is an incision or gap for the nose, while the upper edge of the box supports the forehead. On the inside of the box the holes corresponding to the tubes may be rapidly closed and opened by spring diaphragms, the triggers of which appear above the cover of the box. The other end of the box is closed by two metallic plates which slide over each other, in each of which there is a vertical slit, ¼ mm. wide. In the middle of the box there is a metallic septum or diaphragm with a similar vertical slit. The patient being placed in position, with the eyes in contact with the short tubes destined for them in one end of the box, the box is closed, and the opposite end turned toward a brightly illuminated window. The small disk which covers the left eye-tube or ocular is then opened, and the corresponding metallic plate at the other end of the box is made to slide in and out until the eye sees the slit in the central diaphragm illuminated. The axis of vision of the eye then corresponds with the direction of the ray of light passing through the slit in the central diaphragm and through the slit in the metallic plate at the end of the box. The latter plate is then left in position, the disk covering the left ocular is closed, and the same procedure is carried on with the other eye, only with the opposite end-plate. As the distance of the centres of rotation of the eyes from the central diaphragm is the same as the distance of the latter from the plates or diaphragms at the end of the box, the distance between the two nodal points is equal to the distance between the two vertical slits in the diaphragm. This may be read off on a scale placed on the diaphragm at the end of the box. In this way the position of the two eyes is determined, as well as their distance from each other. (Foster.)

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* Donders' reduced eye, whose first principal focal length F′ is 15 mm.

Chibret's chromatophotoptometer of. See **Chromatophotoptometer of Chibret.**

Chickenpox. Varicella. In this disease the skin of the eyelids may, according to Comby, be affected; sometimes it appears first in this region. Römer has reported a case of varicella of the lids in a child 8 months old. It seems that the conjunctiva is rarely affected by the eruption, but iridochoroiditis and optic neuritis have been observed by Hutchinson, although he did not believe that the intraocular disease was the result of the chickenpox. Steffan has, however, described acute iritis as probably due to the disease.

Chicory. It has been suspected by some observers that this substitute for coffee is capable of producing ocular symptoms. Lewin and Guillery think that such a result is possible although there is no direct evidence available. The oculo toxic symptoms—if there are really any—are possibly due to agents with a pyridin basis.

Chicoyneau, Michel. Probably born at Bois, France, he became a physician at Montpellier in 1652. He also held a number of chairs in the Monspelliensian University. In extreme old age, he became blind, dying in 1701.

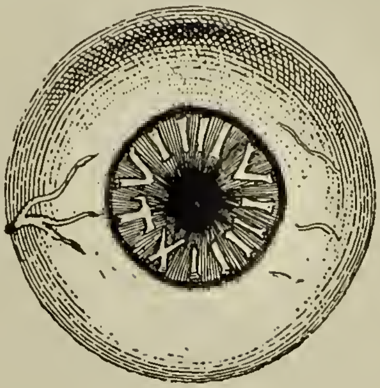
He is now and then mentioned in connection with the Montpellier school because of a thesis which he wrote in 1659 by way of competition for a professorate, and which is called *"An Ophtalmiæ Vinum?"* It is a very brief affair, of no value.—(T. H. S.)

Chief, The. The name by which Avicenna was most commonly known among the Arabians. His real name was Abu Ali al-Husain b. Abdallah b. al Husain b. Ali as-Siah ar-rais Ibn Sina. See **Avicenna.** —(T. H. S.)

Chief point. The point of intersection of the incident and emergent portion of a ray, if produced.

Chief ray. The central ray of a beam of light, or the axis of a conic pencil of light.

Chiffres et lettres de l'iris. (F.) Letters and figures on the surface of the iris. The crypts and various colored patterns on the iritic surface have in some instances been translated by the credulous into actual figures and letters. For instance, Wilde (of Dublin) mentions a case in which the words *"Napoléon Empereur"* were clearly portrayed on the iris of a child. The illustration depicts a case mentioned by Tenon in which the letters T and V were clearly stamped on the surface of the iris.



Letters and Figures of the Iris.

(From the Musée Depuytren.)

Childhood, Eye diseases of. Although it is not intended to repeat here the various congenital diseases (which are necessarily those of infancy and childhood), yet it must be admitted that a number of acquired affections are essentially juvenile. Among these may be included the various phlyctenular diseases, ophthalmia neonatorum and such growths as *glioma retinæ* that, while not strictly congenital in all cases, invariably arise during the earliest years of life.

The most important consideration is, however, relief of refractive errors and care of the eyes during childhood.

The normal child is born hypermetropic and without astigmatism. The myopic child is either defective from birth or has acquired myopia from the stress of eyestrain through the ''turnstile of astigmatism.'' Astigmatism is not congenital, but is practically always acquired in the normal child during the early years of life by excessive strain on the muscles of accommodation.

Kindergarten and primary work should be so arranged as to avoid strain on the muscles of accommodation of the eye, in the plastic years of childhood. Hence, sewing and all wearying exercises should be limited in amount, if not absolutely eliminated.

Systematic study should be begun only when the delicate and soft tissues of the child's eyes have attained sufficient formation to resist distortion on moderate use of the accommodation. This means that the prolonged close work should not be allowed until the age of 10 or over. A child beginning systematic study at that age will, with suitable care, be able at 16 or 18 to acquire all the knowledge possible to its more precocious companion, and will have the inestimable advantages of normal eyes and healthy physique. No young child should be encouraged to compete with its companions for prizes. Mental and ocular overstrain are the inevitable results of such educational monstrosities. In the primary schools especially there should be no grading of the children.

A child incapable of the prolonged use of the eyes at the proper age should not be classed as lazy. In the majority of cases there will be found uncorrected refractive error.

Inability to concentrate the mental attention and deficient powers of observation are often caused by bad visual memory resulting from eyestrain.

The symptoms and physical signs of eyestrain in children can be easily recognized, and there is no more brilliant success in medicine than that which follows the correction in children of refractive overstrain.

The *serious ocular diseases of infancy and childhood*, i. e., those that produce blindness, are given in the tables of Magnus, whose first group covers the period from birth to the age of fifteen, and the figures give the percentage of lost vision in each disease:

Glioma retinæ	1.52
Measles	2.66
Scarlet fever	2.66
Small pox	4.18
Typhoid fever	2.28
Acute exanthemata	1.90
Atrophy of the optic nerve	15.58
Detachment of the retina	2.28
Various other retinal diseases	2.66
Diseases of the uveal tract	7.22
Diseases of the cornea	8.36
Sympathetic ophthalmia	6.08
Traumas	1.52
Conjunctivitis diphtheritica	0.38
Trachoma	0.76
Blennorrhea neonatorum	38.78

See, also, **Hygiene of the eye; School children, Eyes of; Conservation of vision.**

Of the many schemes for the prevention of certain eye-defects of childhood one, that of Bishop Harman may be mentioned. He (*Ophthalmic Review,* July, 1913) has submitted a plan for the safe education of children with such a degree of myopia that they are not fit for the ordinary school curriculum, yet are not bad enough to require the teaching for the blind. In any scheme of compulsory education, there must be provision for misfits, and for none was this more necessary than for high myopes, who often had great intelligence and hence were in danger of damaging their delicate eyes by over-application. He explained the method of selection of cases and their transfer to centres for special instruction. The curriculum fell into three parts: (1) Oral, the children being associated with scholars of the ordinary school for subjects which could be taught orally. (2) Literary work, which was learned not by books, pens, or paper, but by blackboard and chalk, the writing to be done free-arm fashion. (3) A full use of the handicrafts which would develop attention and concentration with a minimum use of the eyes. His conclusion was that a suitable system of teaching myopes could be arranged and satisfactorily carried out. Such classes should not be independent units, nor be associated with existing blind schools, but should be integral parts of existing elementary schools. Their success depended almost wholly on the intelligence and initiative of the teachers, who were required to do real teaching. The training of these children should be general, not merely technical. The classes should be of small size, with an optimum number of a dozen per teacher, and there should be a standard of visual acuity of 6/18 with suitable glasses. The children should also be under regular medical supervision during the whole of their school life.

Children, Eye diseases of. See **Childhood, Eye diseases of.**

Chiliagon. A plane figure of a thousand sides and angles.

Chilo-angioscope. An optical apparatus for observing the circulation of the blood in the human lip.

China bark. A name of cinchona bark, often met with in books. It is a term in common use in England.

China, Native ophthalmology of. From the very highest antiquity, the native medicine of China has been divided into a rather large number of specialties—still another proof that specialism is no new thing beneath the sun. Even today the number of these specialties is said to be 11, as follows: Diseases of the mouth and teeth; diseases of the larynx; diseases of the bones; skin diseases; acupuncture; diseases of women: diseases of the blood-vessels; fever; small-pox; and diseases of the eyes. In the latter specialty are found two surgical operations: paracentesis and the passage of a thread through the eyeball. The latter procedure is said to be performed for the cure of soft cataract (in place of our discission) and to shrink an enlarged and totally sightless eye. In general, it may be said that the native ophthalmology of China is very little understood outside of China.—(T. H. S.)

Chinarinde. (G.) Cinchona bark.

Chinin. (G.) Quinine.

Chinino. (It.) Quinine.

Chininum. See **Quinine.**

Chinosol. See **Quinosol.**

Chionablepsia. (L.) Snow-blindness.

Chionotyphlosis. (L.) Snow-blindness.

Chionotyphlotes. (L.) Snow-blindness.

Chiracantium. A European spider whose bites sometimes affect the eyelids and anterior parts of the globe.

Chiragon. CECOGRAPH. A writing machine for the blind.

Chironien. (F.) Difficult to cure; inveterate.

Chirurgia oculare. (It.) Ophthalmic surgery.

Chirurgie. (F., G.) Surgery.

Chirurgische Eingriffe. (G.) Surgical procedures.

Chitin. $C_{15}H_{26}N_2O_{10}$. The substance composing the chief part of the exoskeleton of many invertebrates, as crabs, lobsters, etc. It is the animal analogue of the cellulose of plants. When heated with concentrated HCl it is decomposed into glycosamin and acetic acid. *Glycosamin* ($C_6H_{13}NO_5$), crystallizes from alcohol in fine needles, is dextro-rotatory, and reduces Fehling's fluid to the same extent as does dextrose, but is not fermentable.

Chiton. (L.) A tunic, an investment, or covering.

Chiton rhagoides. (L.) Obsolete. The chorioid and iris taken together.

Chiusura delle palpebre. (It.) Closure of the lids.

Chlamydozoa. Also spelled CLAMYDOZOA. The name given to the trachoma bodies of Prowazek and Greeff. We now know that they are not specific evidence of this disease having been isolated in other affections. For example, Pascheff (Graefe's *Archiv f. Ophthalm.*, 73, p. 175) believes, from considerable histological examination of (clinical) trachoma and cases of conjunctivitis apparently not trachomatous, that if we are to accept the trachoma bodies as pathognomonic of trachoma, we must accept as trachoma some cases in which the clinical picture is that of acute catarrhal conjunctivitis, and in which the lymphoid infiltration may be quite diffused.

The conjunctivitis in the first case, a woman of 50 years, had lasted five weeks before it was seen by Pascheff. Two weeks' treatment by perchloride compresses and silver nitrate solution sufficed to restore the conjunctiva practically to normal. The second case, in a man of

65 years, had lasted four months before coming under Pascheff's observation. There were some small corneal infiltrations.

It is well recognized that the boundary zone of many trachoma follicles is ill-defined. Pascheff, especially in acute trachoma, includes both large and small follicles without any boundary zone of small lymphocytes. These *germ centres* consist of an aggregation of large pale lymphocytes undergoing active proliferation. Pascheff finds no essential difference in structure between trachoma follicles and other lymph follicles, but distinguishes between follicles and "granulations," reserving the latter term for aggregations of follicles, either fused together or not.

He dwells particularly upon the existence in many cases of very small bulbar follicles, distributed at any point between fornix and limbus. The use of the loupe may be required for the detection of these small elevations. He finds follicles in the fornices frequently associated with phlyctenules at the limbus. He affirms a closer connection between follicles and blood-vessels than is generally admitted.

He thinks the existence of a lymphatic diathesis plays a considerable part in the development of trachoma. He has found in many cases of trachoma, in the secretion and once in a section of tissue, a small Gram-positive bacillus, frequently in diplo form. It grows readily on common media, and must be regarded as a saprophyte. (From an abstract in the *Ophthalmic Review,* May, 1910.)

Much more recently, Isabolinsky and Spassky (*Zeit. f. Augenheilk.,* Feb., 1913, p. 109), reported their investigations of 200 cases in the eye department of the Government Hospital at Smolensk. Of these 11 were acute, 93 chronic, trachoma, 96 other inflammations of the conjunctiva. One example was the conjunctiva of a rabbit and there were 5 cases of blennorrheic vaginal secretion, of which one contained gonococci. Scrapings of the conjunctiva and the secretions in the blennorrheic cases were dried on slides, fixed for from 10 to 15 minutes in methyl alcohol and placed for from 20 to 24 hours in Giemsa solution.

The nuclei of the conjunctival cells were intensely pink, the protoplasm uniformly light blue. In acute trachoma the positive results were three times as numerous as the negative, while in chronic trachoma the negative results surpassed the positive results. Taking both together, 48 per cent. were positive, 52 per cent. negative.

In the non-trachomatous cases the percentage of positive findings equaled that of the trachomatous. In some forms of acute conjunctivitis, acute, chronic and epidemic, the number of positive results was greater. Twenty-three per cent. of the cured cases were positive, 51 per cent. of the not cured cases. Only in one preparation of normal human conjunctiva were inclosures found; the other eye showed chronic trachoma with pannus and corneal ulcer.

A curious but not unique observation is that of Huntermüller and Paderstein (*Oph. Review*, May, 1913), touching a series of fourteen cases of infective conjunctivitis in young men and boys. These were observed during four consecutive summers, the appearances closely resembling those of acute trachoma. The first cases seen were in attendants at public baths, most if not all of the other patients having utilized the same institution. The majority of the patients were natives of Berlin, among whom genuine trachoma is not of frequent occurrence, and the attacks from which the patients suffered left behind, in several instances, a certain amount of change suggestive of trachoma. No bacteria were discovered but in some of the cases cell-inclusions closely resembling the Prowazek bodies. In apes upon whose conjunctivæ the authors succeeded in transplanting the disease chlamydozoa were also discovered. Schultz and Fehr described a similar affection the result of frequenting public baths, in 1899. See, also, **Clamydozoa**; and **Trachoma**.)

Chlamydozoa blennorrhea. A form of ophthalmia neonatorum contracted before birth, which Halberstädter and Prowazek regard as a specially infectious disease, not due to the gonococcus but to organisms resident in the discharges in which the chlamydozoa were found. See **Bacteriology of the eye (trachoma).**

Chloanopsin. VISUAL GREEN. A greenish pigment found in the retinal rods of frogs and some reptiles. It resembles visual purple in the higher animals, and is similar in its properties and functions.

Chloasma. This is a pigmentary hypertrophy frequently found as a result of pregnancy and uterine diseases. In many instances the dark pigmentation is found upon the eyelids and in the neighborhood of the eye. The treatment is difficult. Care must be exercised in the application of whatever remedy is employed, since all must necessarily be more or less irritating. Strong bichlorid solutions are probably the best.—(J. M. B.)

Chlor. (G.) Chlorine.

Chloracetic acid. This is a colorless liquid, a mixture of chlorinated acetic acids. It is sometimes used for removing warts from the palpebral skin, and for touching up phlyctenular ulcers, especially the recurrent form in children.

Chloral. CHLORAL HYDRATE. This well-known agent occurs as loose crystals or crusts with a peculiar pungent odor and taste. It is quite soluble in water, alcohol, and ether. It melts at 58° C. and boils at 97° C. It is generally used as a hypnotic, antispasmodic, antiseptic and analgesic, in doses from 10 to 30 grains, usually given in syrup or as an elixir. It is also used locally as an antiseptic wash in from 1 to 5 per cent. watery or alcoholic solutions.

The prescription of chloral hydrate as a local remedy in ophthalmology seems to be quite rare and there is no reason to think that it is of any especial value. However, as an antiseptic compress and detergent Buchardt advises the following mixture: Acid. salicylic., 0.70; chloral. hydratis, 1.50; acid. boric, 30.00; sol. aquæ chlorinatæ (1:20), 1000.00.

The *toxic effect* of chloral hydrate on the eyes is seen in the production of amblyopia and opacities of the lens.

De Schweinitz mentions among all the ocular forms of intoxication from this drug the following: Temporary amaurosis (Fischer-Dietschy and K. Murphy); amblyopia, faint color scotoma, and hyperemic disk, which disappeared after the habit was stopped (Mittendorf); intoxication-amblyopia with color scotomas and intact peripheral field Levinstein); and defective sight analogous to that seen in hysteria, due to paresis of the ciliary muscle (Förster). It must be admitted that the cases are indefinite and the etiological relationship of chloral to the amblyopia somewhat uncertain.

Chloral hydrocyanate. TRICHLOROLACTONITRITE. This agent is produced by the action of anhydrous hydrocyanic acid on chloral and forms colorless crystals with an odor of both chemicals.

It may be used as a satisfactory *substitute for cherry laurel or bitter-almond water owing to its exact dosage.* One part dissolved in 160 parts of distilled water makes *bitter-almond water the strength of the P. G.* The only question that arises is whether in *collyria* it is as free from irritating effects upon the eye as the best examples of these important vehicles. See **Brenzcain.**

Chlorate of potash. $KClO_3$. This salt occurs as transparent, shiny, colorless plates or prisms, or as a white powder, with a cooling, saline taste. It is quite soluble in cool water, less soluble in hot water, and is generally used as an internal and external antiseptic. In membrane-forming conjunctivitis it is used as a topical agent, and is sometimes employed as a collyrium in the more chronic forms of conjunctival diseases. In toxic doses it has been known to produce an amaurosis, but this effect is rare.

Chloräthyl. (G.) Ethyl chloride.

Chloretone. A trichlorbutylalcohol. $C_4H_7OCl_3$. It is prepared from acetone and chloroform, and appears as snow-white crystals with a camphorous taste and odor. It is soluble in cold water to the extent of 0.80 per cent.; freely soluble in ether and oils.

This useful antiseptic and analgesic is often combined with cocain and other alkaloids, generally in the proportion of 1 per cent. It is a favorite remedy of some for the relief of the burning and smarting that so often accompany the lid hyperemias of eye-strain. The formula generally employed is: Chloreton., 0.10 grm. (gr. 7/10); sodii boratis, 0.50 grm. (gr. 7½); aquæ dest., 30.0 c.c. (f℥j).

G. E. Blackham writes that he always uses a *saturated solution of chloretone* as a menstruum for making up solutions of cocain, atropia and other alkaloids or salts for *collyria*. He finds it preserves them better than any other antiseptic and knows of no contraindication to its use.

As a collyrium in *irritative affections of the conjunctiva* Nelson Black prefers the following formula: Chloreton., 0.075; sodii borat., 0.25; sol. suprarenalin. (1-1000), 2.00; sol. sodii chlor. norm., āā 15.00.

Chloride of lime. See **Chlorinated lime.**

Chlorides, The. The ocular relations of the various chlorides will generally be found under the name of the basic radicle, e. g., *chloride of zinc* under **Zinc, Chloride of.**

Chlorinated lime. CHLORIDE OF LIME. See **Lime, Chlorinated.**

Chlorine water. AQUA CHLORATA, P. G. AQUA CHLORI. An aqueous solution of chlorine containing from 0.4 to 0.5 per cent. of the gas. It is a clear, yellow-greenish fluid, with the acrid smell of free chlorine, easily decomposing into hydrochloric acid and oxygen. It is a stimulating, disinfectant mixture whose virtues are due to the chlorine it contains.

This agent is a very old (in Europe especially a favorite) professional and lay application to the eye as a germicide and astringent. Indeed it is by some surgeons believed to be our most reliable minor antiseptic. I have been deterred from its use in collyria mainly because of its uncertain action, its irritant character and liability to decomposition. Moreover, in my opinion, for American patients several substitutes for it are quite as effective and more comfortable. If used at all it should be freshly prepared and protected from the light. A 5 per cent. solution is sufficiently strong for ordinary purposes, although abroad it is used in much larger proportions. Chlorine water was much used by von Graefe in many conjunctival diseases, especially in conjunctival phlyctenules, for which he prescribed two or three instillations daily of a 50 per cent. solution with compresses of the same remedy. As a compress, a teaspoonful to a cupful of hot water is about the correct quantity. This may be applied for ten to fifteen minutes at a time, three or four times daily.

As a germicide substitute for mercuric bichloride Percy Friedenberg prefers the fresh solution in the proportion of a fluid drachm to a fluid ounce in a pint of distilled water. It is better to begin with the weaker solution. He instills the mixture into the eye with a pipette every hour, if necessary.

Several observers have advised the intraocular injection of chlorine water in suppuration of the ocular interior, as a substitute for the iodoform discs of Haab and other powerful antiseptics, but it is questionable whether the remedy is of much use for that purpose. See, also, **Lime, Chlorinated.**

Chlornitrobenzol. This poisonous agent is one of the components of Roburite, the continued inhalation of which in the form of powder, or exhalations, is capable of producing the amblyopic symptoms of nitrobenzol (q. v.).

Chlorochrous. Having a yellowish-green colour.

Chloroform. $C H Cl_3$. This powerful agent is well-known to the ophthalmologist as an anesthetic. It is a highly refractive, sweet-tasting, heavy liquid, with a characteristic odor. It is miscible in all proportions with alcohol, ether, benzine and oils. It boils at 60 to 62 degrees C. It is the least safe of the general anesthetics and should never be administered by unskilled hands. If ether anesthesia is contra-indicated it may be used but only by an experienced administrator. It is probably less liable to be followed by vomiting or other untoward sequelæ than is ether but its dangers are greater and its administration calls for constant vigilance. It has, however, the advantage over ether of quicker action and smaller doses are required. Close watch must be kept of the pulse and respiration as very little or no warning is given of the approach of danger.

The Esmarch mask or a folded napkin may be used as the vehicle for this anesthetic. It should always be given by the ''drop'' method and with an open mask, as the inspired air should never contain above 5 per cent. of chloroform vapor; 3 per cent. would be much safer.

An empty mask is first applied and, shortly thereafter, a very few drops of chloroform are dropped upon it, gradually getting the patient accustomed to the odor and the interference with full breathing. Drop by drop and very slowly more chloroform is added until the patient is anesthetized with as little excitement as possible.

The pulse should be constantly watched; any change in its character should be regarded as a danger signal.

Amblyopia from this agent is not unknown, although it rarely occurs. The account given by Lewin and Guillery of toxic amblyopia from this source consists mainly of pupil anomalies; myosis and mydriasis have been noticed both after the inhalation and ingestion of this agent. In addition to this, detachment of the retina and "weak" sight have been reported, but it is quite questionable whether there are any genuine, special, ocular symptoms due to the action of chloroform. See **Anesthesia in ophthalmic surgery.**

Chloroform, Legal relations of, in ophthalmic surgery. See **Legal relations of ophthalmology,** in middle third of section.

Chloroïde. (F.) Resembling chlorine.

Chlorolymphoma. Another name for chloroma, regarded by some observers as a variety of lymphoma containing lymphocytes.

Chloroma. GREEN CANCER. This neoplasm is a rare and very malignant form of lymphoma (although regarded by some as a true sarcoma) in which the new growth is colored a yellowish green by a hematogenous or fatty pigment. It arises from the lymphatic glands and generally affects the orbit, reaching it sometimes from the maxillary antrum, the ethmoid or sphenoid cells or from the brain. It is occasionally bilateral. It occurs early in life, the average of reported cases being 15 years. The tumor is hard and may become so large that the lids do not cover the eyeball. The lymphatic glands of the neck become enlarged, the blood shows an excess of leucocytes, and hemorrhages occur from the mucous membranes. In Ayres' case the immediate cause of death was hemorrhage from the conjunctiva.

The history of a patient suffering from this rare disease is given by Merrill and Bedell (*British Med. Jour.,* Sept. 21, 1907). After examining the histories of the 44 cases thus far reported they summarize the ocular symptoms as follows: *exophthalmos is the most common symptom.* The orbital tumors ranged from small, smooth masses not attached to adjacent tissue to firm growths replacing all orbital structure. The temporal veins were usually found dilated. The lids, in some cases, were edematous, puffy, swollen, everted, infiltrated with large movable tumor masses or with smooth swelling, not adherent to the skin. The conjunctiva has been reported as being anemic, congested with venous dilatation, brown infiltration, green discoloration, invaded by a fleshy translucent growth with ramifying vessels, or bloody effusion with fatal hemorrhage. In all extreme grades, the cornea was opaque because of the proptosis. In some cases completely lost. The sclera has been pale, and in another case hemorrhages were found in the scleral tissue. The vitreous was only examined once, and was then normal. Subcutaneous hemorrhages were seen in and about the eyelids; chemosis, photophobia, tenderness of the eyeballs and pain in the eyes have all been mentioned. Loss of motility varied from the paralysis of a single muscle to total ophthalmoplegia.

Optic neuritis was present in at least ten cases; if the patient lives long enough, optic atrophy follows. Other conditions have been pale nerves, exudation in nerve head and hemorrhage into the nerve tissue. Numerous hemorrhages, from minute spots to large linear extravasations, have been noticed in the retina. The vessels have been described as pale, rosy or distended and tortuous; most often venous stasis is present. The outcome has been invariably fatal.

R. Sattler (*Trans. Amer. Ophth. Soc.,* xiii, p. 214, 1912), also gives a full account of this subject.

Bedell records (*Annals of Ophthalmology,* July, 1912), an additional case of this rare tumor. At the autopsy this growth was found to be widely disseminated, as tumor cells were found in the lymphatics and bloodvessels. The predominating cells were of the lymphatic series, and occurred in a delicate reticulum, the amount of connective-tissue varying according to the nature of the tissue invaded. Cells of the myelocytic series and endothelial cells, single and multinucleated, occurred in varying numbers. The tissues invaded by the tumor underwent different forms of degeneration with resulting inflammatory reaction. The origin of the pigment was not evident. It is necessary to study it in fresh or suitably fixed tissue as the ordinary methods are of no use.

Again Bedell (*Ann. Ophth.,* July, 1912), reports two cases. One in a boy aged eight, and the other in a girl aged eighteen. In the latter case a full laboratory report is made of all the organs of the body. Pathologically, the disease is characterized by growths, most frequently multiple, in connection with the bones of the face, orbit and other regions. Macroscopically the growths vary in color from a dark olive to a very light pea-green which fades rapidly on exposure to air or the various fixation fluids. The color is probably due to a lipochrome which is found in extremely variable amount even in the cells of the primary growth. Tissues invaded by the tumor undergo different forms of degeneration with resulting acute and chronic inflammatory reaction of slight to moderate degree. The nature and source of the pigment is not evident. The ocular manifestations are many and varied. The eye balls become proptosed and the vision lowered, the eye-lids show great dilatation of the bloodvessels, the conjunctiva chemotic, paralysis of ocular muscles, optic neuritis and lagophthalmos are all present in varying degrees. The orbits become filled with nodular growths.

The blood count showed in his first case 1,410,000 reds and 79,000 whites, and in his second case 2,200,000 reds and 52,000 whites. The disease runs a rapid course resulting in death in from one to two months' time.

Sattler, of Cincinnati (*Arch. Ophth.*, Sept., 1912, XLI, 452), reports a case of chloroma in a boy aged 11 years. Among the earliest signs were prominence of both eyes and symmetric tumor masses in both lids and orbits, due to displaced and enlarged lachrymal glands. This was followed by a rapid subperiosteal growth filling apex and walls of both orbits. Autopsy showed extensive involvement of the cranial cavity and other organs of the body.

A clinical history of the case, with autopsy findings, is given and a bibliography is added.

Chlorophane. A yellowish-green chromophane, (q. v.).

Chloropia. Disordered or defective vision in which objects appear green. See **Chloropsia.**

Chloropsia. Green-vision. Up to the present time only a few cases of green-vision have been observed and described. For example, after the extraction of a lens for the relief of myopia, a thirty-two year old artisan who was suffering from tabetic optic nerve atrophy, saw everything an emerald-green; after severe exhaustion there would appear to him red points on a green field. Green-vision developed in a physician after having slept for a few hours in the full sunshine. Alter describes a case of green-vision (which he calls monochromatopia for green) in a color-blind paralytic. In a tabetic, the field of vision appeared in green and violet spots, and the same condition was present with the eyes closed. One case of green-vision was observed as an aura (abortive epileptic attack) in a twelve year old girl.—(C. P. S.)

Chlorosis, Ocular symptoms of. The *photophobia* and irritability often observed in the eyes of chlorotics are usually traceable to conjunctivitis and blepharitis, and these again may result from overtaxing of a weakened accommodation, which often leads to hyperemia of both the external and internal eye.

The usually harmless swelling of the eye-lids in this disease calls for a careful urine-analysis in order to detect a possible nephritis.

In chlorosis a rapid increase of myopia, or decrease of hypermetropia, is not uncommon and is probably due to diminished resistance of the sclera. Moreover, opacity of the vitreous and the inflammatory changes at the posterior pole are observed in cases of chlorosis which are absent in the common form of progressive myopia.

Anemia and chlorosis have been described by some as the cause of all kinds of diseases of the eye but it seems clear that in many of these reported cases they are dependent upon incidental complications. Thus, iritis, scleritis, iritis serosa, and opacities of the vitreous accompanying forms of uveitis posterior have been attributed to these constitutional diseases.

Relapsing vitreous hemorrhages in young individuals have also been observed in anemia, and without doubt that condition is due to it.

Optic nerve disorders, especially certain forms of neuritis, are much more certainly and more closely related than are the foregoing. Outside of true *neuritis optica*—the causes of which may be intracranial—only a certain form of papillary congestion occurs, according to Schmidt-Rimpler. This form of congestion can be traced to a purely edematous process accompanying a hyperemia. Vision may be normal or nearly normal and so continue a long time under these conditions. Occasionally the disc is much swollen, although the elevated papilla appears clear and transparent and has a faint, edematous appearance; in other cases it is a simple edema. The vessels are but little changed, although the retinal veins may appear darker, enlarged and tortuous. In some cases white opaque bands are seen in the papilla and white plaques have been observed in the retina not unlike those found in albuminuric retinitis. These hyperemic or inflammatory changes may go on to atropy.

Retrobulbar neuritis in anemics may follow lactation and are analogous to the forms occurring in alcohol and nicotine intoxications. These forms, too, may end in partial atrophy.

Malignant *atrophy of the optic nerve,* similar to that following amaurosis from excessive hemorrhage (white discs and narrow arteries) with almost complete blindness in both eyes has been observed.

It is doubtful whether *narrowing of the visual field* is ever of purely anemic origin. In most of these cases we probably have to deal with hysteria or similar nervous conditions. This is perhaps true of *hemeralopia,* which ordinarily can be traced to such direct causes as fasting, etc.

The *prognosis* of all chlorotic eye-disorders depends upon the degree of the primary disorders. Retrobulbar neuritis generally permits a favorable prognosis even if a partial degeneration of the optic nerve has taken place, and the same observation holds good of papillitis edematous in character. A favorable outcome may also follow those forms of papillitis which are caused by hemorrhages into the sheath or the trunk of the optic nerve. In the juvenile form of relapsing hemorrhages into the vitreous humor the prognosis is decidedly unfavorable. (*Encyklopädie der Augenheilkunde.*)

Parsons believes that in chlorosis and anemia *fundus changes* are infrequent. He further says that "Raehlmann in eighty-six cases of general anemia found definite retinal anemia in 20 per cent., normal fulness of the vessels in 20 per cent., and marked dilatation in 60 per cent. In the last group the blood in the veins is lighter in color than normal, and the reflex streak is more conspicuous. Gowers attributes the broadening of the veins to diminished distension and to the flattening under the intra-ocular pressure. The brighter and broader reflex streak is no proof of greater intra-vascular tension. Schmall found the vessels normal in 20 per cent. of all chlorotics; in 80 per cent. the vessels looked pale and narrow, but the veins are often twice or thrice as broad as the arteries. Schmall records tortuosity of the arteries as a feature of chlorosis.

''Pulsation of the arteries is common (Becker v. Noorden), and is usually only a locomotion pulse (Schmall, Friedrichson). Raehlmann divides the cases into two groups: those with arterial pulse and hyperemia, and those with retinal anemia and no pulsation. The former are plethoric individuals and the pulsation is attributed to hydremia. According to Thoma the vessel walls are more extensile in anemia, thus facilitating distension and tortuosity. Schmall attributes the arterial pulse to the short, sharp cardiac pulse-wave with diminished general blood-pressure and diminished tension of the arterial walls. Progressive peripheral centripetal venous pulse has been observed.

''Retinal hemorrhages have been described (Elschnig), but it is doubtful if the cases were simple anemias. Knies records the typical appearance of albuminuric retinitis in one eye only, lasting six months and disappearing entirely when the general condition improved.

''Optic neuritis and neuroretinitis have been frequently recorded (Bitsch, Dieballa, Oliver, Schmidt, Bannister, Riegel, Engelhardt, Uhthoff, Wescott and Pusey, Hawthorne, Pick). The diagnosis must in many cases be accepted with reserve. Some are undoubtedly pseudopapillitis, occurring generally in hypermetropic eyes and persisting indefinitely without disturbance of vision. In some cases hemorrhage into the nerve sheath affords the most reasonable explanation, *e. g.,* Litten and Hirschberg, where a central scotoma gradually disappeared, the anemia associated so frequently with intracranial tumor must not be overlooked in this connection, especially where bilateral choked disc is indisputable; the syndrome—headache, vomiting, and optic neuritis—may be very misleading if localising symptoms are absent or slight. Thrombosis of the cavernous sinus as an explanation of optic neuritis and atrophy (Hawthorne) is in most cases highly improbable. Thrombosis of the central vein (q. v.) has been ascribed to chlorosis (Ballaban). Scleritis, chronic iridocyclitis, rapid increase of myopia, etc., occur in anemic individuals, but the etiological relationship is unproved. Diminished coagulability is probably responsible for recurrent spontaneous vitreous and orbital (Wagner, Brunetière) hemorrhages."

According to Croftan (*A System of Ophthalmic Therapeutics,* p. 271), the underlying taint in chlorosis seems to be more a perversion of lymph formation than of blood formation. There is no anatomical evidence of disease of the blood-forming organs nor are there any marked quantitative changes about the cells nor any signs of degeneration. There is in every case of chlorosis a strong neurotic element manifesting itself chiefly about the vaso-motor system. The treatment of this disorder must therefore chiefly be directed against this neurosal element more than against any anemic condition of the blood.

Rest is the most important element in the treatment. The patients should be put to bed and kept there for several weeks; if possible removal from home surroundings should be arranged and the patient either sent to a hospital or given the benefit of care in an open-air sanitarium. Removal from home combined with rest often alone effects a cure.

Certain hydrotherapeutic measures are also of great value. The same applies to massage. The details of these methods cannot be described within the narrow confines of this article. The diet should be arranged according to the secretory and motor conditions of the stomach and intestine. One point may be emphasized in this place, viz., the advantage of using the abnormal cravings that most of these patients exhibit as a guide for the selection of diet. Some patients crave acids, others chalk or other alkaline material, still others highly spiced articles of food. These idiosyncrasies should be considered. Broadly speaking chlorotic subjects do best on a diet consisting largely of vegetables and cereals and containing a minimum of meat and other animal albumen.

As most chlorotics are constipated this diet is particularly indicated. Daily copious evacuations of the bowels should be accomplished as it is not impossible that underlying all cases of chlorosis will be found a chronic intestinal toxemia originating in persistent coprostasis.

The medicamentous treatment of chlorosis calls chiefly for iron; but this remedy can in no way be considered a specific, although it is frequently declared to be such. Many cases of chlorosis get well without iron and on the above simple regime; on the other hand many cases fail to improve even when very abundant quantities of iron are administered. Iron, nevertheless, is the best remedy we possess and it should be given in every case. The administration of iron is best accomplished by Blaud pills. I have never been able to convince myself that organic iron preparations have any determinable advantage over inorganic iron. Perchloride of iron (through a tube to save the teeth) and reduced iron are both useful. The name of official and unofficial iron preparations is legion and it would be useless to enumerate them all. If there are severe gastric symptoms, gastritis, gastralgia, gastric hyperesthesia iron should not be given at all until these troubles are relieved.

Arsenic is less important in chlorosis. Small doses of Fowler's solution or of arsenious acid or cacodylate of soda can, however, do no harm. Mineral waters containing iron and arsenic are a convenient and pleasant way to administer these two remedies. Bottled iron waters are as a rule useless as most of them contain the iron in solution as carbonate of iron; the carbonic acid soon escapes and the iron precipitates; under these conditions the water contains very little iron in solution. It is well, therefore, to advise the drinking of ferruginous waters, not bottled, but at their source; in this way, too, the patient obtains the benefits of resort life, change of scene, etc. And it is probable that in most instances the latter factor is by far more beneficial than the drinking of the iron waters.—(A. C. C.)

Chlorosis, Tropical. A synonym of uncinariasis or hookworm disease. See **Ankylostomiasis,** Vol. I, p. 487, of this *Encyclopedia.*

Chlorquecksilber. (G.) Chloride of mercury.

Chlorschwefel. (G.) Bisulphide of carbon.

Chlorwasserstoffatropin. (G.) Atropine hydrochloride.

Choanoid muscle. A term of comparative ophthalmology, applied to a hollow muscle *retractor oculi* or *musculus oculi choanides* which, in the larger herbivora and certain reptiles, surrounds the optic nerve and is attached by its apex to the margin of the optic foramen and by its base to the sclerotic coat of the eye.

This muscle really occurs neither in apes nor in men, though the contrary was universally supposed from the beginning of the Alexandrian period, 500 B. C., till the middle of the 16th century. Two facts seem to account for the long-continuance of the error: (1) In all those mammals whose orbits open towards the temples (i. e., the larger herbivora) this muscle does actually exist. (2) It was precisely these larger herbivora (especially swine) that constituted almost the sole available dissection material throughout the period mentioned.*

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* To the action of this supposedly present muscle it was that Galen attributed the power to behold very small (therefore close) objects—what we call the "accommodation." He made it entirely clear that he had in mind something altogether different from the fixation of the object looked at—i. e., the directing toward it and holding upon it of the two visual axes. With him, therefore, in a vague sort of way, the retractor muscle performed the same identical function as, with us, the ciliary muscle.

The following is a highly condensed history of this matter: Prior to the Alexandrian period, the very nature and function of muscular tissue was unknown. In fact, muscles, tendons, and nerves were hopelessly confused together, all three having been supposed to be somehow concerned with sensation and also with the protection of deeper and more important parts. The Alexandrians (by which are meant all the physicians of the Greco-Roman world from B. C. 300 till the beginning of the middle ages) did, indeed, perform a few dissections on the human cadaver, but they dissected so much more frequently the bodies of the lower animals that all their oculo-anatomical and oculo-physiological ideas were founded upon the facts obtained from these animal dissections. Galen (131-210 A. D.) declares that the movements of the eye are produced by the ocular muscles. Of these he mentions seven: four straight, which move the eye inwards, outwards, upwards, and downwards; two oblique, by which the rotary motions of the eye are brought about; and a seventh, or retractor muscle, which arises near the roots of the other six, envelops the optic nerve, and is inserted into the outer tunic of the globe behind the insertion of all the others. As Galen's anatomy was "law, gospel, and prophecy" throughout the middle ages, we can hardly be astonished that the old idea of a retractor muscle being connected with the human eye prevailed unquestioned by anyone at all throughout the entire medieval period. However, the mistake lived even longer—in fact it passed the watchful eye of the great Vesalius, to be corrected for all time to come by Gabrielle Fallopia (*Latine,* Fallopius) (1523-1562). —(T. H. S.)

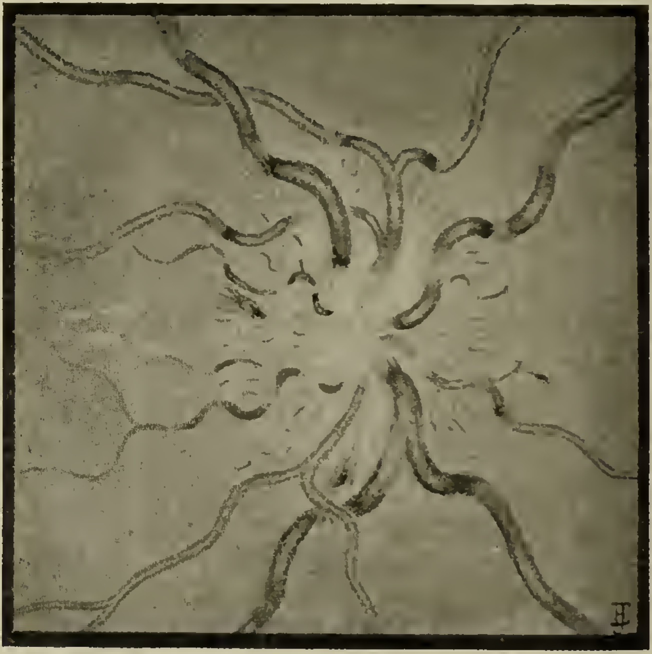
Chocolate, Amblyopia from. Cases of amaurosis or amblyopia from this agent (that is from the active principle *theobromin*) are very rare. and when they occur may be regarded as unusual examples of idiosyncrasy. The Editor (*Medical Record,* Vol. 48, p. 843, 1895) has recorded a case of temporary amblyopia in the form of a migraine with scintillating scotoma. It was also his belief that minor defects of vision in the form of asthenopia are recognized as probably due to this same agent.

Lewin and Guillery (*Die Wirkungen von Arzneimitteln und Giften auf das Auge,* Vol. 1, p. 449), recount an instance of a woman whose vision became very poor every time she drank chocolate. The same writers also report the history of a man 54 years of age, who, on drinking chocolate, experienced a migrainous headache with peculiar scotomata in front of his eyes. These symptoms were followed by the reduction of vision to finger counting, although sight returned after half an hour. In several of these cases neither cocoa alone nor vanilla nor the other flavorings employed in the manufacture of chocolate produced amblyopic symptoms; hence one may assume that it was the chocolate alone that affected the visual apparatus.

Choerangeiokeratoditis. (L.) (Obs.) Scrofulous keratitis with the formation of new blood-vessels.

Choerolymphokeratoditis. (L.) Obsolete term for scrofulous lymphatic keratitis.

Choked disc. PAPILLITIS. STAUUNGSPAPILLE. INTRAOCULAR OPTIC NEURITIS. NEURORETINITIS. NEURITIS OPTICA. PAPILLEDEMA. Under these headings is generally described the alterations in the normal optic disc and retina observed in certain cases of intra-cranial turmor, mastoid infection, Bright's disease, and a number of other vascular and central nervous affections. The edematous papilla is seen by the ophthalmoscope to project decidedly above the level of the surrounding retina. The disc margins are blurred and spread out like the head of a mushroom and the retinal vessels are tortuous and bent. Sometimes the vascular outlines are clearly defined but more frequently they are obscured by gray or whitish exudates. Sometimes very white patches and hemorrhages are seen.



Optic Neuritis (Choked Disk) in a Case of Tubercular Meningitis.
Optic disk hidden by gray striated swelling; retinal veins very large and tortuous.—(Jackson.)

Symptoms of choked disc. Intra-ocular optic neuritis may show no symptoms aside from the ophthalmoscopic signs. Often vision will be normal or only slightly reduced; but it may be markedly impaired. The external appearance shows nothing that is characteristic of the condition. If complete blindness ensues, the pupil will be dilated and the iris will be immobile. Visual acuity may be normal, slightly or much reduced, or abolished. If the macular bundle of nerve-fibres is involved, vision will be seriously affected. The field of vision may present peripheric contraction, sector-like defects, enlargement of the blind spot, scotomata, or hemianopsia. The fields for red and green are generally lost before those for other colors. Color-perception may be defective in persons who present no loss of visual acuity and no limitation of the form-fields. It is evident that little dependence can be placed upon the subjective symptoms. The diagnosis must rest on the findings of the ophthalmoscope.

The *ophthalmoscopic appearances* include hyperemia with edema of the nerve-head; obscuration of the outlines of the disc; the presence of a papillary swelling of the optic-nerve head of greater or less degree; hemorrhages; and dilation of the retinal veins, the arteries being of normal calibre or contracted. The swollen nerve-head, with its numerous distorted vessels, makes a characteristic picture. *The nerve-head* may present only a slight hyperemia, slight swelling, and blurring. In pronounced cases the swelling forms an elevation of several dioptres' height. The elevated area is of a grayish-white color, is clouded, and presents radiating striæ. It gradually runs into the surrounding retina. The boundaries of the nerve-head are obliterated and the location of the papilla becomes known only by the convergence of the vessels. The hyperemia, which is often intense, may be confined to the area of the swollen papilla or may also involve the adjacent retina. Hemorrhages are often seen in the swollen tissue. In cases of intra-cranial growths which have produced double (bilateral) optic neuritis, attempts have been made to distinguish cerebral from cerebellar growths by the appearance of the swollen disc. Oliver states that in subtentorial (cerebellar) tumors the disc looks denser and harder than in cases in which the tumor is situated in the cerebrum. *The vessels* in papillitis are tortuous and resemble a bundle of angle-worms. The veins are dilated, tortuous, and dark. The arteries are tortuous, and are either of normal or of diminished calibre. Both arteries and veins are partly concealed by the swollen tissue. The light-streak is present. The adventitia may be thickened, causing the appearance of white lines along the vessels. The tortuosity of the vessels makes a picture which has been compared to the head of Medusa. *Hemorrhages,* which are usually small, are not uncommon. They may be limited to the area of the swollen papilla or may involve the retina as well. They may assume various forms. When existing in the nerve-fibre layer of the retina, they are of flame-shape. Only a single hemorrhagic spot may be present or there may be numerous such areas.—(J. M. B.)

DeSchweinitz (*Diseases of the Eye,* p. 614) observes that periphery of the *field of vision* is important in these cases and it may at first be unaffected. Later it may "show irregular and concentric contraction; the increase in the size of the normal blind spot, which becomes correspondingly great in comparison with the amount of swelling; the formation of an abnormal blind spot or scotoma due to involvement of the axial fibers and sometimes to destruction of the ganglion-cells; the absence of half of the visual field (hemianopsia) when the intracranial mischief which may have been the cause of the neuritis or choked disc is so situated as to produce this phenomenon; and finally, defective color-perception, which may exist when there is no change in central vision and no limitation of the form-field. Cushing and Bordley have found reversal of the color lines as it occurs in hysteria in association with increased intracranial tension, with and without choked disc, as well as blue-blind areas, which disappeared after the restoration of intracranial tension to normal by operation."

Cushing and Walker have recently (*Archives of Ophthalm.,* Nov., 1912, p. 559) given some valuable observations on the *anomalies of the visual fields* in brain tumor and choked disc, concluding that a constriction of the field of vision due to a destruction of fibers more complete from the temporal than from the nasal half of the retina and justifying the designation of nasal hemianopsia has been observed in from 5 to 6 per cent. of a series of 300 cases of brain tumor. It occurs as a late sequel of an advanced choked disc in the stage of recession of the edema; and a bilaterally symmetrical process, implying an equal degree of involvement of the two eyes, suggests as a rule a distant, often a cerebellar, lesion with secondary hydrocephalus. An internal hydrocephalus with distention of the third ventricle crowds the optic nerves downward and outward against the carotid vessels which transversely indent the outer aspect of the nerves. In this way the uncrossed fasciculi to the temporal retinæ, and the laterally placed macular bundle as well, suffer from a mechanical pressure "block" in addition to the diffuse anatomical destruction of fibers throughout the nerve in consequence of the contraction of the new-tissue formation in the long-standing choked disc. A similar involvement of the uncrossed fasciculi in the absence of tumor may occur, as originally suggested by Knapp, through the pressure effects of diseased and sclerosed vessels. In this event the coincident constriction of the fields shown by our series of tumor cases would hardly be expected, owing to the fact that with cerebral arteriosclerosis a choked disc, though common enough in moderate degree, rarely advances to the stage which we have shown to be associated with the form of binasal hemianopsia under discussion.

Pathogenesis of choked disc.—In spite of the attempts of the advocates of the two different theories, the mechanical and the inflammatory, to attribute all cases of optic neuritis and choked disc to one common pathogenesis, it is becoming more and more evident that different pathological processes may produce the same macroscopic and microscopic picture in the optic nerve and disc. Since our conception of the pathogenesis is the basis for treatment, we may be permitted to enter into it in some detail.

When v. Graefe (*Gazette Hebdom.*, Nov., 1859. See, also, Ueber Complication von Sehnervenentzündung. *Arch. f. Ophth.*, VII, 1860, pt. 2, p. 59), first gave the name "Stauungspapille" to this condition, he considered it due to venous congestion in the optic veins, because in some cases, even with hemorrhages present, he found no signs of inflammation in the nerve.

Virchow (Ueber Complication von Sehnervenentzuendung mit Gehirnkrankheiten. *Arch. f. Ophth.*, VII, 1860, pt. 2, p. 58. Also, Tumor Orbitæ et Cerebri, *Arch. f. Ophth.*, 1866, XII, p. 100), on the other hand, found inflammation of the nerve trunk in a case of meningitis with disc changes of only moderate degree, which he assumed to have been communicated to the nerve from the meninges, and to this form Graefe gave the name "descending neuritis."

Therefore, even in Graefe's time, we find, just as to-day, a two fold pathogenesis of optic neuritis.

The "descending neuritis" was supposed to be characterized ophthalmoscopically by only a slight degree of swelling in the disc and a tendency to invade the retina; while the cases associated with increased intracranial pressure ("Stauungspapille" of Graefe, or "choked disc" of Clifford-Allbutt, e. g., tumor, were characterized ophthalmoscopically by a high degree of swelling limited to the disc, the retina remaining more or less unaffected.

We now know that these ophthalmoscopic differences, as given above, are artificial, and that cases associated with high intracranial pressure may present only a slight disc change, or none at all, while meningitis, pyemia, intoxications and other conditions associated with a "descending neuritis," and without other evidence of increased intracranial pressure, may present the typical appearance of choked disc, so that we no longer attempt to make an ophthalmoscopic, etiologic diagnosis between "descending neuritis" and "choked disc."

Graefe considered that choked disc was produced by the increased intracranial pressure damming back the circulation of the eye by pressing on the cavernous sinus. He thought that this mechanical effect was still further enhanced by the effect of the rigid scleral foramen.

This theory of pressure on the cavernous sinus received a severe setback, in 1869, when Seseman (Die orbitale Venen des Menschen und ihr Zusammenhang mit den oberflächlichen Venen des Kopfes, Reichert, u. du Bois-Reymond's *Arch.,* 1869, p. 154), showed that the communication between the orbital and facial veins is so free that pressure on, and even obliteration of, the cavernous sinus produces no intraocular changes. This was further corroborated by Hutchinson's (quoted by Gowers, *Medical Ophthalmoscopy,* p. 75) case, in which complete obliteration of the cavernous sinus by pressure from aneurysm produced no eye changes.

It was Schwalbe (*Cbl. f. Med. Wiss.,* 1869, p. 465), in 1869, who first showed that the subvaginal space around the optic nerve is continuous with and can be injected from the subdural space, and who pointed out the significance of the fact in connection with choked disc.

Carion, Manz and Schmidt-Rimpler showed how frequent is the distension of the optic sheath in neuritis, and tried to produce optic neuritis by injecting the subdural space with fluid; and in some cases a transient swelling and redness of the disc resulted, but no typical neuritis. Schmidt-Rimpler found that fluid injected into the sheath passed into the lymph spaces in the nerve at the lamina cribrosa, and he suggested that pressure inside the nerve and perhaps irritation from the fluid in the nerve causes the neuritis.

Schmidt's and Manz's views were widely accepted in Germany.

Leber threw his influence in favor of the inflammatory theory, in 1881, in a discussion at the International Medical Congress, in London, and here first used the term "papillitis." He rejected the theory of Manz that the fluid acts by mechanical pressure, and also failed to verify the connection between the sheath and lymph spaces of the nerve, asserted by Schmidt-Rimpler. He assumed that the fluid in the sheath excited neuritis by conveying pathological material into the optic nerve behind the eye. Deutschmann published additional evidence in favor of Leber's theory.

Other theories of the origin of optic neuritis which have arisen only to be discarded are: (1) The "foreign body" theory of Hughlings Jackson and Brown-Sequard; (2) Vaso-motor theory of Benedikt; (3) Inflammation by continuity theory of Galezowski; (4) Basal meningitis theory of Edmunds and Lawford; (5) Theory that neuritis optica intraocularis is the expression of a general cerebral edema, the effect of distension of the ventricles of the brain (of Parinaud).

In more recent years the Schmidt-Manz mechanical theory has been upheld by Schulten, Bramwell, Oppenheim, Hoche, Merz, as well as v. Bruns and Cushing. Uhthoff, Saenger, Axenfeld, and Kampfferstein speak of rigid lamina cribrosa, in addition to increased intracranial pressure, as furthering intraocular passive congestion.

The Leber-Deutschmann theory has been vigorously upheld by Knies and Gowers, who believe in a descending neuritis, Elschnig, who first used the term papilledema, and by Jacobson and Fleming.

But whether the process in the nerve and nerve-head is inflammatory in nature (as evidenced by round-cell infiltrations, exudate, edema. hemorrhages, increase of nuclei), or merely a passive congestion and edema, it is certain that in the great majority of cases, and particularly in those in which an increase in intracranial pressure is demonstrable, decompressive operations lead to retrogression of the eye conditions, and even to the complete or almost complete recovery of vision in eyes previously nearly, though rarely quite, blind.—(A. E. H.)

Schieck's theory.—This observer (*N. Y. Med. Jour.,* March 26, 1910) bases his hypothesis on the investigations of Gifford and Levinsohn, who have proved that the posterior vitreous lymph is led off in the perivascular lymph spaces of the central bloodvessels. This fluid stream meets the one that flows away from the brain, along the optical sheaths, at a point where the axial strand enters into the subarachnoid space together with the central bloodvessels. Both fluid streams are then led outward through the perivascular sheaths of the central bloodvessels, which pierce the dura from the intervaginal space. As soon as an increase of intracranial pressure produces even a slight increase in the fluid pressure in the subarachnoid space, the vitreous lymph is prevented from leaving the axial strand. But this does not occur (as Levinsohn supposes) through the inflammatory influence of the pathologically modified cerebrospinal fluid from the cerebral disease, followed by the congestion of perivascular lymph spaces of the axial strand; but on the contrary, purely physically, through over-pressure in the intervaginal space which makes impossible the outflow of lymph from the lymph channels into the space. The lymph which has been accumulating more and more in the axial strand leads to a considerable enlargement of the perivascular spaces and finally to edema of the axial strand. From here out the infiltration progresses with great rapidity over the whole cross-section of the distal end of the optic nerve. At the same time through ectasia of the lymph spaces a mechanical compression of the bloodvessels in the axial strand results, and finally an exfoliation of the intima due to pressure from the transudate between the coverings of the bloodvessels. Because of this, the lumen of the central bloodvessels is generally diminished. —(Ed.)

As the result of experimental work, Levinsohn (*Archiv. f. Oph.*, Oct., 1906), concludes that in the subvaginal space of the optic nerve only a very sluggish circulation of fluids takes place. After ligation of the optic nerve in cats and rabbits, only a slight congestion of the subvaginal lymph takes place if the central vessels are not included in the ligature. A slight stasis in the nerve took place distalwards from the snare only when the central vessels were also ligated. Following this there occurred a slight outflow of cerebrospinal lymph from the brain through the subvaginal space of the opticus and from the eye along the axial fibers. Both streams had their exit from the nerve through the perivascular spaces of the central vessels. An injection of cinnabar into the subarachnoid under slight pressure almost immediately filled the subvaginal space and penetrated the perivascular spaces of the penetrating central vessels, especially at the beginning of the axial fibers.

A stasis which appeared at the proximal end of the nerve section after ligation counteracted in a decided manner inflammatory symptoms in the nerve sheath, so that in severe inflammation at the site of the hydrops an obliteration of the subvaginal space took place. In the portion of the subvaginal space united by inflammation, the color particle did not penetrate after injection of the subarachnoidal brain space. After subarachnoidal injections the pigment penetrated freely all of the subarachnoidal spaces of the brain and spinal cord and collected especially at the base and around the nerve and vessels in particular. Similarly it nearly always penetrated all of the ventricles as in the upper portion of the spinal cord. The sites of entry were the foramen Magendie and the aperaturæ lateralis ventriculi quarti, in which location it followed principally the surface of the plexus chorioidei.

Three factors have to do with the origin of choked disc: the increased intracranial pressure and the inflammatory changes in the cerebrospinal lymph cause a blockage of the perivascular lymph tracts of the central vessels and produce a stasis in the egress of the intraocular fluids, all of which soon leads to inflammatory phenomena. The increased pressure within the subvaginal spaces does not produce the stasis through compression of the lumen of the central vessels. This is proven by the rarity of cases of choked disc in which there were the anatomically correct sequence of this condition, namely, severe retinal hemorrhages.

Deyl's theory.—This acute observer (*System of Diseases of the Eye,* Vol. III, p. 603), remarks that "it can be taken almost for granted that in pointing out the main features of the *ophthalmoscopic picture* of choked disc every examiner will state that he finds some particular vein or both central veins distended. It is equally evident that if compression produces this dilatation the pressure exerted cannot be great, because the appearance presented here is totally at variance with the picture of pronounced compression with which all are so familiar,—for instance, in thrombosis of the central vein of the retina. It is therefore justifiable to assume that a comparatively slight obstacle impedes the outflow of blood in the central vein. Even under such circumstances, however, it is evident that the egress of blood from the smaller venous branches upon the papilla will also be interfered with, and it follows as a natural consequence that the serous exudation as well as the resulting discoloration will be most pronounced in those places where the nerves as well as the small (and in the present case) distended blood-vessels are most numerous,—that is, in the upper and lower portions of the nasal half of the optic disc. This supposition is verified by the prominence and discoloration which actually occur in the locality indicated.

How is this compression of the central venous trunks of the retinal vessels produced? It is plain that compression can be caused by anything that interferes with the normal flow of blood in the central vein, during its course along the axis of the optic nerve, in its oblique passage from the nerve-trunk into the intervaginal space, in its exit through the dural sheath, and, lastly, during its progress and distribution external to the sheaths.

These preliminary facts being admitted, according to the writer's researches the origin of the choked disc takes place in the following way:

"The vein passes out from the nerve-trunk through a narrow slit which can often be made out even by the unaided eye as a gray line in the pial sheath. (As a rule, the vessels will be found close together here, the opening for the central vein being a little nearer to the eye than the point of entrance for the central artery of the retina.) If the vein is compressed in the constricted orifice mentioned above (whose lip-like edges swell under the slightest edema), the slight initial stasis that often occurs can be explained. The edema of the optic nerve arises as a result of the increased tension and the consequent obstruction offered to the outflow of blood and lymph from the cranial cavity, the pressure in question being looked upon by the pathologist as a common and almost constant condition and recognized by the clinician in the living subject as well (the so-called "tense dura"). This compression of the central vein in the passage described above has been demonstrated by the writer in brain-tumors by a series of microscopic sections. It is evident that after hardening and preserving the specimen it is not possible to detect the edema unless it assumes enormous proportions. It is also evident that this compression and stasis tend to increase the existing edema. As a consequence, dropsy of the cavity between the sheaths of the optic nerve may develop, so that the intervaginal space frequently presents an ampulla-like dilatation in choked disc, and is found filled with fluid. This accumulation fluid, under increased pressure, gradually encroaches upon the external sheath and constricts its contents so that the central vein as it passes obliquely from before backward through the intervaginal space is put on the stretch and suffers compression at the inner surface of the dura. In the few instances of cerebral disease (especially in cases of brain-tumor) where this ampulla-like inflation is found unassociated with choked disc, we may assume that death resulted before sufficient compression of the venous channels took place; a condition which, in individual cases, often depends on anatomical causes that affect the exit of the vein from the nerve or from the external sheath."

Six cases of choked disc are reported by W. R. Parker (*Annals Ophthal.*, Oct., 1911), in which the *intra-ocular tension* was carefully estimated with the Schiötz tenometer. He concludes from these observations that in the beginning of the papilledema the greatest edema takes place first in the eye offering the least intra-ocular pressure resistance. If the intra-ocular tension is the same in each eye the papilledema will be the same in each eye. As the edema increases the resistance at the papilla must increase, otherwise the swelling would stop at 7 or 8 D. That the pressure of the papilla does increase is well shown by the atrophy of the optic nerve fibers that follows prolonged pressure from the infiltration. The tension does not increase with increased swelling of the nerves. The use of the tonometer has demonstrated that we are unable to determine accurately the tension of the globe by the use of the fingers, and that there is a marked variation in the normal tension. This variation is present not only in different individuals, but may exist in the eyes of the same individual.

As Parsons also says (*Pathology of the Eye*, p. 1350), "An undue amount of importance has been attached to the conditions of the retinal circulation as an index to those of the intra-cranial vessels. As has been pointed out, the major vascular supply of the eye in lower mammals is derived from the external carotid artery, i. e., from a purely extra-cranial source, though the intimacy of relationship with the internal carotid in its intra-cranial course, which obtains in the higher primates, reaching its acme in man, is foreshadowed by minor anastomoses even in the inferior species. Morphology, therefore, affords a strong argument which we have already seen put to the crucial test of experimental proof, against the overwhelming importance of intra-cranial conditions as affecting the ocular circulation. It is impossible, however, on anatomical grounds alone to suppose that this view can be completely maintained for man and the higher primates.

Under normal intra-cranial conditions, therefore, it would seem to be immaterial, physiologically, whether the ocular circulation is derived from intra or extra-cranial sources, or both. If, however, the arterial supply is wholly or mainly of intra-cranial origin, as in man, or in the dog with ligatured external carotid, whilst the ocular veins communicate freely with both the intra and extra-cranial systems, it is clear that intra-cranial complications may be expected to affect profoundly the ocular circulation, both from the arterial side and also to a less extent from the venous. Any intra-cranial condition which impedes the flow of blood in the internal carotid may be expected to lead to passive constriction of the intra-ocular arterioles; but such intra-cranial conditions usually affect the venous sinuses even more profoundly, leading to partial blockage, with coincident slowing of the circulation. This latter effect, however, will not necessarily lead to increased ocular venous pressure, owing to the free communication with the general system of veins, which themselves anastomose so freely as to tend rapidly to the equalisation of pressures.

The chief cause of papilledema is the presence within the cranium of some adventitious material, which may be solid or fluid. To the former category belong malignant growths, inflammatory deposits, and blood-clots; to the latter distension of the lymph spaces and reservoirs by an abnormal amount of cerebro-spinal fluid, which may also be abnormal in constitution as the result of meningeal inflammation, etc. Clinically the form of adventitious deposit which most frequently gives rise to choked disc is tumor of the brain. Other causes, more or less in order of frequency, are syphilis, tuberculosis, brain abscess, meningitis and hydrocephalus. Rarer causes are anemia, nephritis, sinus thrombosis, cysticercus, deformities of the skull, etc."

Behr (*Bericht der Ophthalm. Gesellsch.*, 1912, page 14) again devotes himself to the exposition of his theory of the pathogenesis of choked disc which he first published in 1911 in the *Neurologisches Centralblatt,* and which corresponds closely to that adopted by Wilbrand and Saenger. As he says, too many of the theories have been built on much too slender a foundation, and reliance has been placed on features which may be present in some cases but which equally certainly are absent in others, such as the signs of inflammation, or the dilatation of the nerve sheath, or the signs of compression of the central vein in the nerve sheath. Secondly, he considers that none of the principal theories pay enough attention to those cases where the appearances of optic neuritis are produced by causes quite other than raised intra-cranial pressure and where all the evidence goes to show that the intra-cranial pressure is normal.

In making this latter supposition we consider that he himself is taking up an illogical position and assuming that because superficially similar results are produced they must be produced by similar causes. Very similar appearances, as far as the optic disc are concerned, may be seen in albuminuria, in disseminated sclerosis, in syphilitic neuro-retinitis, in accessory sinus inflammations, and in cerebral tumors, but to say that because the appearances are similar the pathogenesis is the same is, we believe, a very serious error, and even simple pathological examination at once reveals essential differences underlying the superficial similarities. We consider it is a quite justifiable course to try to find a theory to explain choked disc in cases of raised intra-cranial pressure, which need not necessarily take any account of the optic neuritis of anemia, leukemia, nephritis, etc.

Thirdly, he considers that none of the theories sufficiently explain the clinical manifestations of optic neuritis of which, in his opinion, the concentric contraction of the fields is the most typical.

Behr's own theory is that the cause of the choked disc is to be found at the intra-cranial end of the optic foramen. He points out that from the upper bony edge of this there projects a fold of dura which continues the roof of the canal for two or three millimetres over the nerve. He regularly found that in all unoperated cases where there had been gross optic neuritis, this dural fold had been pressed into the upper surface of the nerve and had left a definite indentation. The increase in intra-cranial contents causes the frontal lobe to press down from above and at the same time the temporo-sphenoidal lobe presses from below and from the side, and so the optic nerve is pressed into the dural fold above and into the bony edge of the optic foramen below. "In this way there arises a circular compression which must lead to an inhibition of conduction in the peripheral nerve fibres, and so clinically to the typical more or less concentric contraction of the visual fields and later to a destruction (of these nerve fibres) which can be demonstrated microscopically." The temporary attacks of amaurosis are, he thinks, due to blockage of nerve conduction at the same point.

[He does not explain in what manner the ophthalmic artery passing through the same bony canal escapes from the effects of this pressure which yet seems to be sufficient to cause a marked indentation on the nerve surface.]

The blocking of the optic foramen leads to a lymph stasis in the nerve sheath and in proof that this lymph stasis is due to some cause acting at the optic foramen he cites the distribution of the endothelial proliferation and of the edema. [Here he has rather to force his explanation to explain the frequent absence of any sign of edema in the posterior part of the nerve in the orbit.] In this connection he has investigated the main lymph streams from the retina, disc, and nerve and he concludes that these drain back straight into the intracranial cavity and do not to any great extent drain into the nerve sheath (!).

His general conclusion is that “choked disc is in the end only the ophthalmoscopic expression of a general edema of the nerve.” He admits that it is a well known clinical fact that hypophyseal tumors [and though he does not say so, other tumors which press straight on the chiasma or on one or other optic nerve] do not cause optic neuritis, but he explains this by saying that these tumors lift up the chiasma and overlying brain and so free the optic foramen (!) and in this way the nerve escapes any circular compression and leaves room for a free lymph drainage.

In concluding, Behr congratulates himself that Wilbrand and Saenger have adopted his theory of blockage at the optic foramen as the main cause of choked disc, but it needs little reading between the lines to see that their support of the theory is not very whole hearted nor do we think it can escape the very just criticism with which Behr commences his paper, that like so many other theories it is based on too narrow a foundation. (Leslie Paton's abstract and critique, *Ophthalmic Review,* March, 1913.)

Intracranial conditions in choked disc. Brain tumor (q. v.) is by far the most frequent cause of choked disc. In 200 cases of Kampfferstein's (*Klin. Monatsbl. f. Augenheilk.,* April-June, 1906) of choked disc, 134 were due to brain tumor. Had cerebral syphilis and conglomerate tubercles been added, the number would have been raised to 170.

Gowers (*Medical Ophthalmoscopy,* 1904, p. 71) holds that tumor cerebri is also the most frequent cause of optic neuritis, though

R. Greeff (Axenfeld's *Lehrbuch der Augenheilkunde,* 1909, p. 553) is inclined to give the precedence to the various forms of meningitis.

The location of a tumor is of much more importance in the production of choked disc than its microscopic character or specific etiology. In general, it may be said that the tendency of tumors to produce choked disc increases from the anterior to the posterior pole of the brain, and diminishes from the cortex inwards. Also choked disc is somewhat more likely to occur earlier and reach a higher degree on the same side as the tumor.

Paton (Optic Neuritis in Cerebral Tumors. *Trans. Ophth. Soc.,* Vol. XXVIII, p. 112), in reviewing 252 cases of brain tumor, found that tumors of the cortex are more liable to produce optic neuritis and choked disc than tumors of the subcortical white matter and pons, and that the intensity of the neuritis in tumors of the cerebral cortex varies inversely with the distance of the part affected from the anterior end of the middle fossa.

Age is an important factor in the production of choked disc by tumor, youth being much more liable to develop it than age. H. L. Singer, in reporting 88 cases of brain tumor, showed that the average age of 51 cases with well-developed choked disc was 28 years, and of 9 cases without choked disc was 54 years.

Heredity, sex, nationality, occupation play little, if any, rôle.

Tumors of the posterior fossa are especially liable to produce choked disc. They are cerebellar cysts, hemorrhages, sarcoma, glioma, psammoma, endothelioma. The cerebellum is also the location of predilection for conglomerate tubercles and otitic abscesses.

Cerebello-pontine angle tumors most often grow from the acoustic nerve; less often from the adjacent nerves, corpora quadrigemina or cerebellum. Acoustic tumors are usually fibromata, sarcomata and less often psammomata, and not rarely may be bilateral.

Basal tumors and hemorrhages (also of the corpora quadrigemina, pons, medulla, pineal gland, etc.) produce choked disc much less often than the two groups above, perhaps because, owing to early involvement of vital parts, they produce death before they arrive at the choked-disc-producing stage.

Hypophysis tumors and cysts (occasionally gumma and rarely tuberculoma) occasionally produce choked disc, but set up optic neuritis somewhat oftener.

The characteristic eye findings of hypophysis tumor are bitemporal hemianopsia, as a rule; binasal hemianopsia, rarely; bitemporal atrophy, atrophy in varying grades of one or of both eyes, or hemianopsia with atrophy. They usually find an adequate explanation at post-mortems in direct pressure of the tumor on the optic tracts or chiasm, and less frequently on the optic nerves themselves, to reach which a pituitary tumor must be very large and must have a very unusual forward extent.

Erdheim has shown and described the mechanism by which both optic tracts may be caught between the growing hypophysis tumor and the carotid arteries, and crushed between them. Erdheim, in 1909, had another similar case, an unsuccessful attempt at extirpation by Hochenegg, with death from hemorrhage, and in this case the two very rigid sclerotic carotids acted as unyielding bands, between which and the large pituitary tumor the optic tracts had been compressed to a thin, scarcely perceptible transparent ribbon. The patient, needless to say, was completely blind before the operation.

Perhaps the very rare cases of pituitary tumor with binasal hemianopsia are due to such a condition, the pressure of the carotids on the temporal fibers of the tract making itself felt before the pituitary tumor itself has brought about a distinct lesion in the nasal fibers.

From the mechanical theory of optic tract lesions in hypophysis tumors, Schnabel seems to be the chief dissenter. His theory, brought forth in 1906, that the bitemporal hemianopsia is of toxic origin, due to the direct action of pituitary toxin on the nerve fibers, and likening the condition of toxic central scotomata, has not found much support. Physiological and chemical researches since that time, while they have considerably enlarged our knowledge of the pituitary secretion and its functions, have not as yet demonstrated a neurotoxin sufficiently active to produce, unassisted, so severe a nerve lesion as that occurring commonly with pituitary tumor. Moreover, since the appearance of Schnabel's article, the relief experienced from operative procedures in patients, in most of whom only a partial extirpation of the gland has been performed, speaks rather strongly against the toxic, and for the pressure, theory.

Cortical tumors (those above the tentorium) do not usually develop neuritis, though they do so more often than tumors of the subcortical white matter. From the point of view of diagnosis and treatment, these tumors should be divided into those of the (1) sensorimotor area; (2) occipital lobe; (3) temporal lobe; (4) frontal lobe: and also those arising from the (1) meninges; (2) outside the meninges (in the bone and outer surface of the dura); (3) cortex; (4) subcortical white matter and spreading to the cortex.

Cerebral cysts almost deserve a section to themselves, owing to their peculiar, varied and often obscure etiology, as well as the problems which they present in diagnosis and treatment.

They are (1) primarily cystic tumors; (2) solid tumors with secondary cystic degeneration; (3) traumatic cysts—(a) hemorrhage with subsequent absorption; (b) encephalomalacia, etc.; (4) connective issue cysts of Krause; (5) parasitic; (6) lymphatic, etc., etc.

Brain abscess is, according to Oppenheim, who has reviewed the literature up to 1909, in 30 to 50 per cent. of the cases of (a) otitic origin. These otitic abscesses are located either extradurally, in the cerebellum, or in the temporal lobe. They are mentioned here in the order of their frequency.

Extracranial causes of choked disc. Diseases of the accessory sinuses produces brain abscess much less often than ear disease. The location of these abscesses is usually either subdural at the base, or in the frontal lobes.

Abscess following injury may be located anywhere, depending on the site and nature of the trauma.

Pyemic and metastatic abscesses may occur anywhere and do not show the same uniform tendency to attack the region of the basal ganglia that embolic hemorrhages show. We may also mention brain abscesses occurring with bronchiectasis and other purulent affections of the lungs. The route of infection of the brain here is not always entirely clear.

Other sources of choked disc. Intracranial hemorrhages are much less frequently the cause of choked disc than the above-mentioned causes. In fact, in the great majority of cases, even with massive hemorrhages into the meningeal spaces, there are no changes in the eye grounds. Why swelling of the disc is present in the small minority of cases and absent in the others is difficult at present to state, but it seems in line with the relatively small tendency of cortical disease in general to produce choked disc.

Sinus thrombosis in two-thirds of the cases produces no eye changes. Why in some cases and not in others is difficult to say. It cannot be a matter of restriction of the outflow from the ophthalmic veins, since many cases of complete blocking or thrombosis of the cavernous sinus, as first reported by Hughlings Jackson (The Surgical Treatment of Choked Disc. *Ophth. Hosp. Rep.*, Vol. IV, 1833, p. 407), show no fundus changes, the blood escaping freely from the ophthalmic veins by way of the facial and angular veins and their tributaries.

Meningitis is a very common cause of optic neuritis, i. e., of a moderate degree of papillitis, but rarely of actual choked disc.

Epidemic meningitis is a frequent cause of optic neuritis, of which it is often one of the earliest and most valuable signs, as demonstrated by a case seen by the author at Cook County Hospital in January, 1910, in which an examination-room diagnosis of lumbago was changed to one of epidemic meningitis by the finding of a bilateral optic neuritis. This led to a lumbar puncture, resulting in finding pus and the diplococcus intracellularis.

Choked disc, when it does occur in meningitis, is apt to appear late in the disease, when the acute symptoms have disappeared. A remnant of exudate, more or less organized, blocks the foramina of exit of the fourth ventricle (foramina of Magendie, Key and Retzius), and causes an internal hydrocephalus.

Tuberculous meningitis leads to optic neuritis only in rare cases. Tubercles in the choroid are almost as common here as optic neuritis. Choked disc occurs chiefly where large conglomerate tubercles, particularly in the cerebellum, complicate the disease.

Meningitis from other causes (pneumococcus, streptococcus, influenza and pyogenic cocci) leads to optic neuritis in a percentage of cases lying between the two above forms. Choked disc occurs chiefly when they are accompanied by brain abscess, internal hydrocephalus, or pyocephalus.

Hydrocephalus internus, particularly in the chronic form, is a frequent cause of the higher degrees of optic neuritis, choked disc and post-neuritic atrophy.

Whether choked disc in these cases be due to hydrops of the sheath of the optic nerve, edema of the nerve itself, or to pressure of the dilated third ventricle on the chiasm, is not certain. At any rate, it seems likely that the last occurrence may explain the sudden, transient and recurring amblyopias which are an alarming symptom in some brain tumors associated with internal hydrocephalus.

Aneurysm of the cranial arteries, most usually at the base (carotids, vertebral, basilar, circle of Willis, arterio-venous aneurysm, etc.), is one of the rarer causes of choked disc.

Cranial deformity, particularly the "tower skull," which is often associated with an internal hydrocephalus, is a more frequent cause of the swelling of the disc than exostoses, which occasionally, though rarely, present the only demonstrable cause for an existing optic neuritis, which may disappear on their removal.

Brain syphilis produces choked disc chiefly in the gummatous stage, or when associated with hydrocephalus.

Optic neuritis is, however, common, though usually unilateral in the secondary stage, occurring especially along with the second and third roseolar eruptions, rupia, condylomata, iritis, etc., rather than with the primary eruption.

Ear disease. It is chiefly the intracranial complications which lead to optic neuritis, especially abscesses, suppurative meningitis, meningitis serosa, and sinus thrombosis. In a certain (Barr and Rowan. Optic Neuritis with Disease of the Ear. *Ophthalmic Year Book,* 1908, p. 245), though small, number of apparently uncomplicated cases of otitis media there may develop an optic neuritis. It has, however, been noted that later these cases are more apt to present intracranial complications than are those without the accompanying neuritis. Menière's disease may also occasionally be accompanied by an optic neuritis, perhaps due to the same cause which produces the trouble in the inner ear or vestibular tract.

Encephalitis producing any eye symptoms causes optic neuritis of low grade, and very rarely, if ever, choked disc, unless abscess formation intervenes in addition. Encephalitis occurs with acute poliomyelitis with accompanying acute polioencephalitis, scarlet fever and the other exanthems, meningo-encephalitis and trauma.

Post-operative neuritis, as pointed out by Cushing (Bordley and Cushing. Observations on Choked Disk. *Jour. A. M. A.,* Jan. 30, 1909, LII, p. 355), and de Schweinitz and Holloway (The Operative Treatment of Papilledema Dependent on Increased Intracranial Tension. *Therap. Gaz.,* July 15, 1909, Vol. XXV, No. 7, p. 474), though a rare complication of exploratory and decompressive measures, may occur in eyes previously normal. The more usual occurrence, however, is that a previously existing optic neuritis or choked disc for a few days or a couple of weeks after the operation shows a slight or moderate increase in intensity before it gradually disappears or goes over into a secondary atrophy.

Other less important optic conditions, causing optic neuritis, which, however, may be mistaken for those demanding surgical intervention, are multiple sclerosis, paretic dementia, nephritis (neuritis or neuroretinitis), neuritis of pregnancy and puerperium, neuro-retinitis leukemica.

Intoxications, especially with metallic salts, are more apt to produce retrobulbar neuritis than neuritis optica intraocularis, and also are very apt to lead to optic atrophy, e. g., arsenic lead, mercury, alcohol (ethyl and methyl), tobacco, etc.

Lightning stroke is said to be a cause of optic neuritis, but the so-called ''Berlinische Trübung'' is a more frequent fundus change.

Orbital disease is a frequent cause of optic neuritis and choked disc, which is, however, with rare exceptions, unilateral.

The particular varieties of orbital disease causing swelling of the optic disc, especially those secondary to inflammations or tumors of the accessory sinuses of the nose (see **Cavities, Accessory**) are treated elsewhere in this work.—(A. E. H.)

Trantas draws our attention to the fact (*Recueil d'Ophthalmologie,* Jan., 1911) that when retinal hemorrhages occur in cases of papillitis they are usually seen in the neighborhood of the swollen disc. In 200 cases of Uhthoff's cases hemorrhages in other parts of the fundus occurred three times only. In the series were cases of papillitis due to anemia, thrombosis of sinuses, nephritis and syphilis, all possible causes of hemorrhage apart from choked disc.

Trantas re-investigated the matter with the aid of his method of digital pressure for bringing into view the region between the equator and the ora serrata, and in 18 cases of papillitis due to tumour demonstrated the presence of hemorrhages in that region of the retina in eight instances. They were grouped about branches of the veins, and for the most part were few and small, and required careful search to detect them. In the cases in which they occurred the veins were always markedly tortuous and dilated, and the papillitis was advanced. Trantas thinks that these findings may be a help in differential diagnosis, as he has not hitherto found these peripheral hemorrhages in any case of optic neuritis due to other cause than intra-cranial growth.

Sir Victor Horsley (*Brit. Med. Jour.,* March 5, 1910), has furnished proof (see the illustrations) of the following propositions:

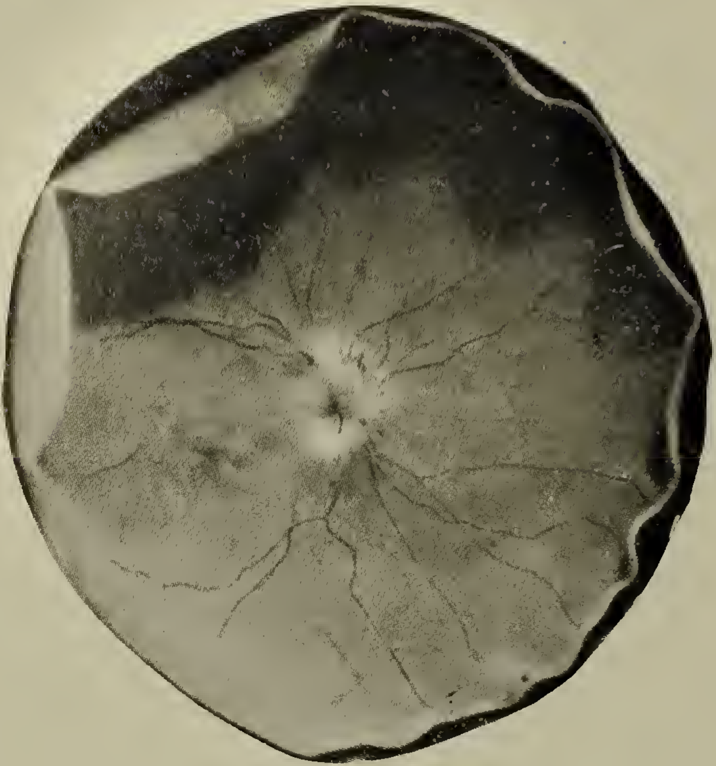
(*a*) The maximal intensity and age of the papillo-edema or optic neuritis in cases of increased intracranial tension is of the highest value in the clinical localization of the lesion, and is ipsolateral with the maximal pressure effects of the latter.

(*b*) Papillo-edema produced by increased intracranial tension commences at the upper border of the optic papilla, and invades last the inferior temporal quadrant.

(*c*) The macular figure, as Marcus Gunn stated, is caused by tension lines centered at the fovea, the greatest stress being just beneath the intima.

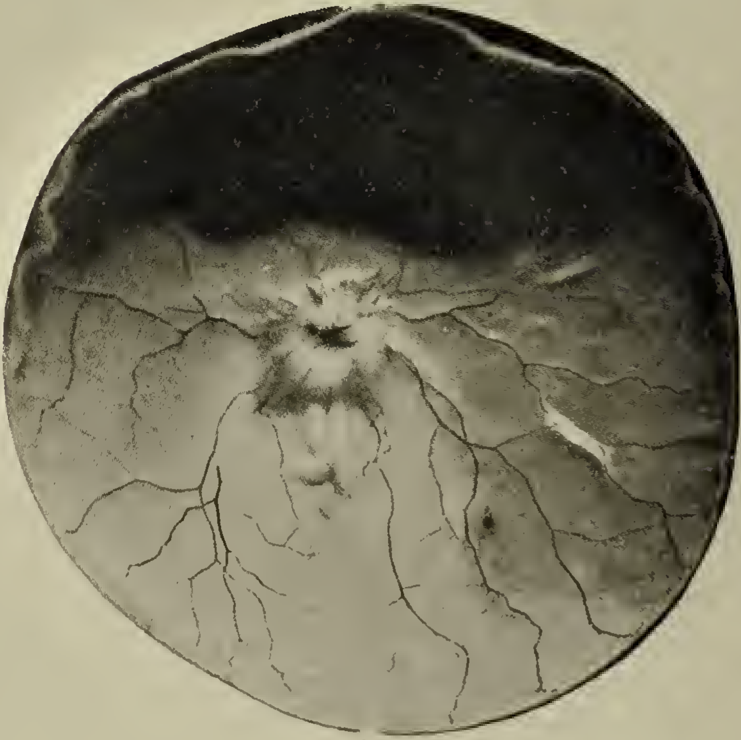
(*d*) The phagocytes of the retina consist of several kinds, as follows: (1) wander-cells; (2) connective tissue corpuscles; (3) epithelioid corpuscles of the nerve fiber layer; (4) epithelioid corpuscles of the outer granule layer—the two latter varieties being in close relation to the supporting fibres of Müller. See, also, **Brain tumor.**

Right.



A.

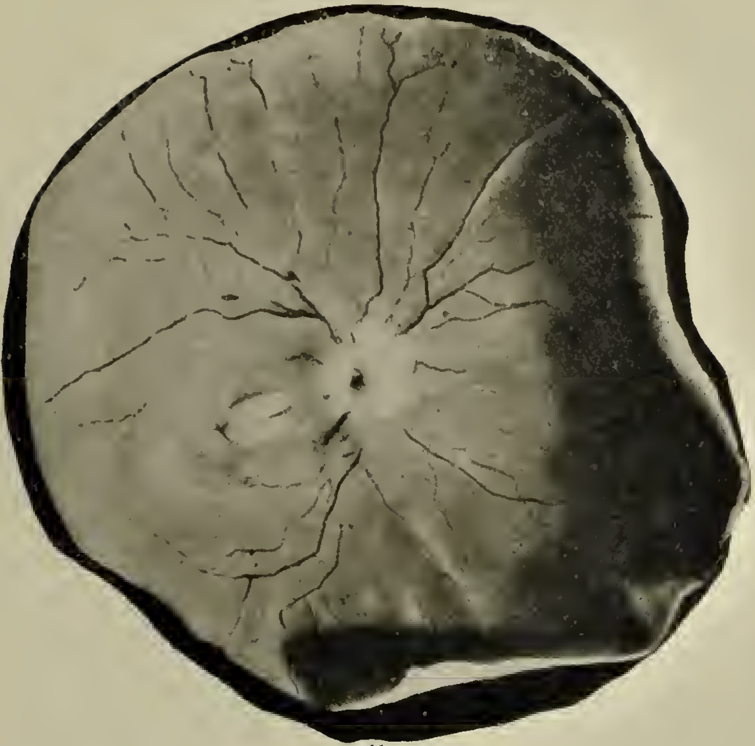
Left.



B.

Tumor of Left Temporo-occipital Region. Note especially the white (degeneration) spots grouped around the nasal disc margin at point of greatest tension. The swelling and changes are most intense on the side of the tumor.—Horsley.

Right.



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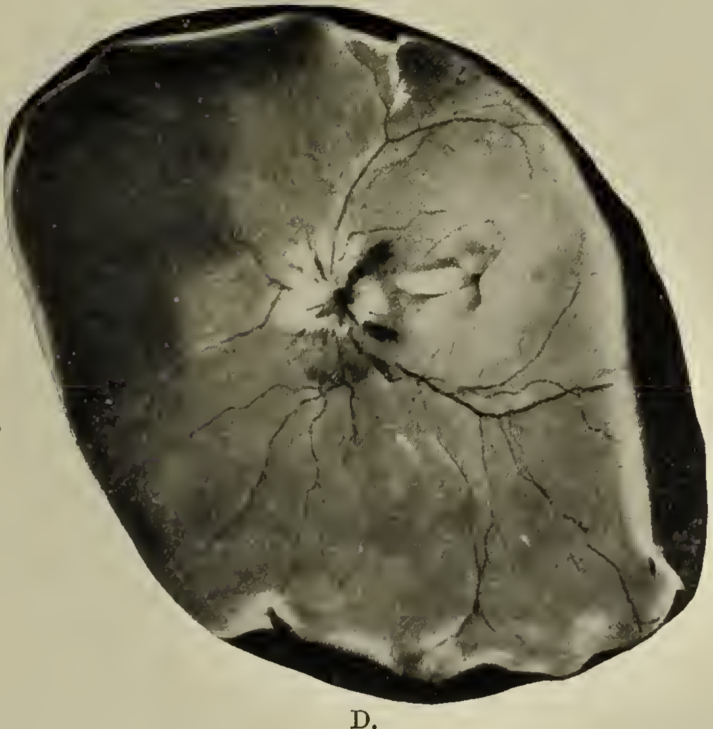
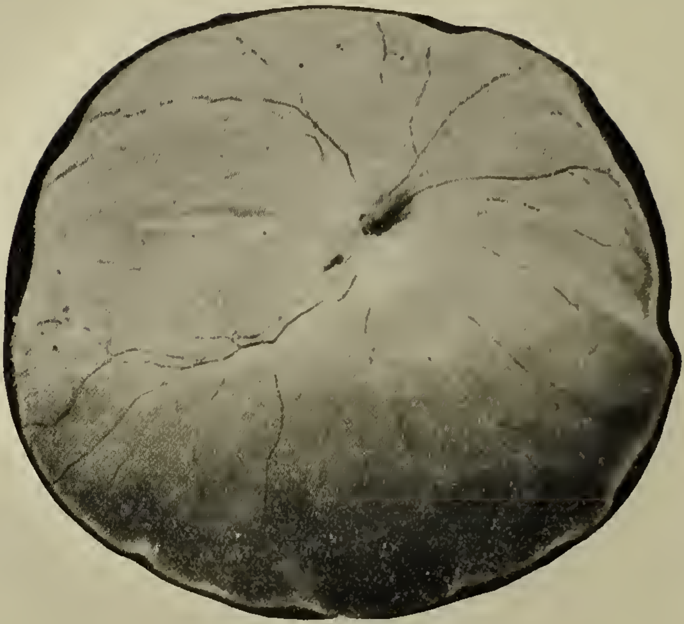


D.

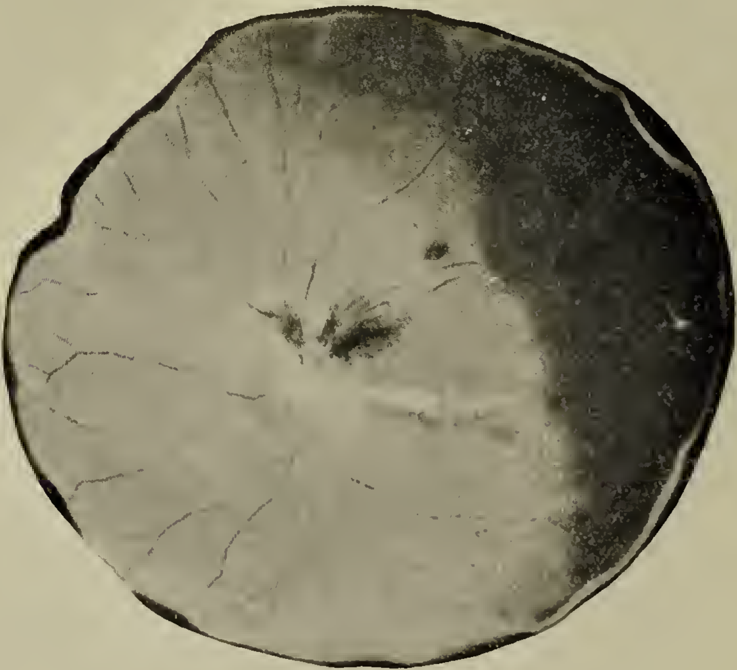
Tumor of left Frontal Lobe. Haemorrhage shortly before death, causing severer papillo-edema and haemorrhages on the ispolateral side. No degeneration spots, owing to brief clinical duration of neuritis.—Horsley.

Right.



E.

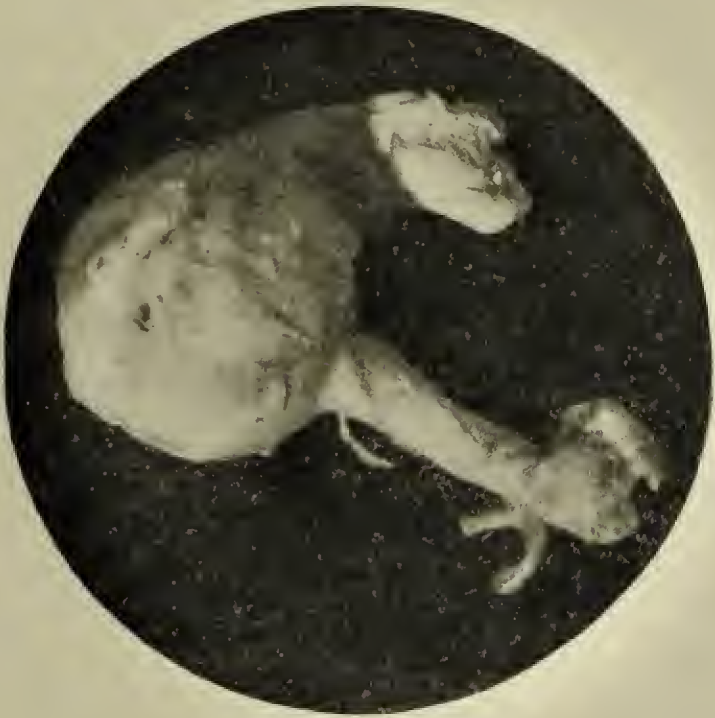
Left.



F.

Tumor of left lateral cerebellar recess; marked ipsolaterality. Note topographical distribution of the papillo-edema on disc; that is, most at upper border, least at inferior temporal region.—Horsley.

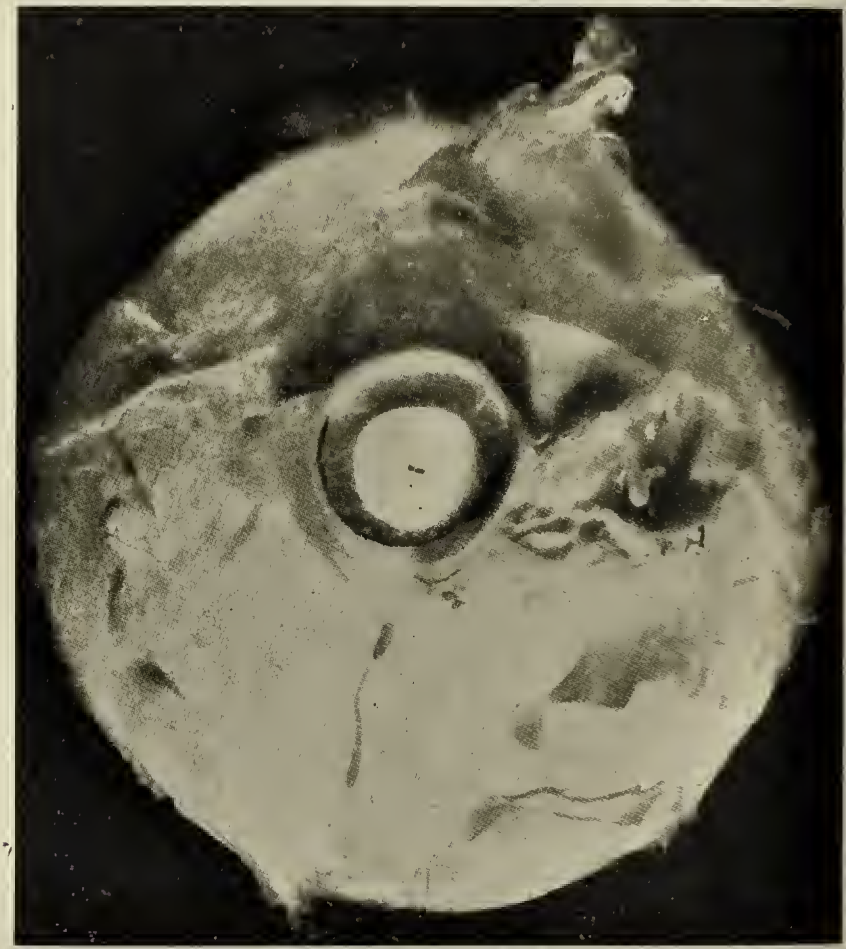
Mohr (*Klin. Monatsbl. f. Augen.*, Vol. L, pt. ii., p. 401, 1912), with a view to determine the *diagnostic importance of optic neuritis when unilateral or greater on one side,* he has analysed some 800 cases in which a post-mortem examination was made. Not all of these, of course, had a bearing on the point at issue, but still the numbers are sufficiently large to give important information. He divides his material as follows: 1. Unilateral choked disc (41 cases). Of these 56.09 per cent. were homolateral, 43.9 per cent. contralateral, to the side of the tumor. In the homolateral cases the seat of the tumor was 12 times cortical, once cortical and basal, thrice in the large nerve centres, twice in the cerebellum. Of the contralateral tumors, 8 were cortical, 1 in the corpus callosum and cortex, 1 basal, 3 in the large centres, 3 in the cerebellum, 1 between the cerebellum and peduncle. In the first group therefore cortical tumors were relatively somewhat preponderant, in the second cerebellar.



G.

Fig. G.—Early optic papillo-edema. Eyeball and optic nerve from case of lateral recess cerebellar tumor. (See Figures E. and F.) Showing that the ampulla due to dilatation of the sheath is more marked on the dorsum of the nerve.

2. Unilateral optic neuritis—not choked disc (10 cases). Of these 80 per cent. were homo-, 20 per cent. contra-lateral. The distribution of the homolateral was as follows: 4 cortical, 1 cortical and basal, 2 basal, 1 cerebellar; the contralateral were both cortical.



H.

Fig. H.—Transverse section of ampulla shown in profile in Fig. G. The nerve sheath is seen to be more distended in the dorsal half. (Magnified 3 diam.) Case of lateral recess cerebellar tumor.—Horsley.

3. Optic neuritis bilateral but greater on one side (65 cases). Of these 71.75 per cent. were homo-, 28.25 per cent. contra-lateral. Distribution of homolateral—28 cortical, 5 basal, 1 in centres, 8 cerebellar, 3 in vermis; of contralateral—11 cortical, 4 in basal nuclei, 3 cerebellar.

4. Choked disc on one side, optic atrophy on the other (7 cases). Probably not all these were instances of post-neuritic atrophy; some

were no doubt due to direct pressure on the nerve. The atrophy was always on the side of the tumor.

5. Optic neuritis bilateral but retinal changes (hemorrhages, etc.) greater on one side (12 cases). Homolateral 33.3 per cent.; contralateral 66.6 per cent. Homolateral cases—4 cortical, 1 cerebellar; contralateral—5 cortical, 1 in thalamus, 2 cerebellar.

On the whole therefore these figures support the contention of Paton that in any individual case the amount of swelling of the papilla on one side as compared with the other is of little value in determining the seat of the tumor. Group 5 also is strongly against the idea that it is the amount of retinal change and not the mere degree of swelling which is of chief importance. (Abstract by Geo. Coats, *Ophthalmic Review,* Feb., 1913, p. 438).

Treatment of choked disc.—Von Hippel (*Bericht der Ophthalm. Gesellsch.,* 1912), is fully convinced that "To-day it is no longer a question for discussion whether choked disc should be dealt with surgically, but rather which is the most efficient surgical method in dealing with it." Of course if a radical operation is possible the matter is simple, but there remains a number of cases in which radical operation is not feasible. The possible methods then of palliative operation are five in number: (1) lumbar puncture, (2) ventricular puncture, (3) trephining, (4) puncture through the corpus callosum (*balkenstich*), and (5) ventricular drainage. Ordinary ventricular puncture and ventricular drainage are not dealt with in the paper. Lumbar puncture, von Hippel rightly considers too dangerous a proceeding especially when there is the chance of the tumor being sub-tentorial. He has little to add to what he has already said on the subject of palliative trephining.

The observations of Velter have shown that in suitable cases, good results can be obtained without opening the dura. The full operation would be done in two stages and of these the dural opening is the more severe. He considers it most important that a general anesthetic can be dispensed with. Von Hippel next considers in detail *the value of transcallosal puncture* in cases of choked disc. His conclusions are: (1) That "by this method a complete and permanent (2½ years) healing of the choked disc without atrophy and with preservation of function may be obtained; (2) there are cases in which the method fails but in which a subsequent decompression leads to disappearance of choked disc; (3) in other cases the efficacy of the transcallosal puncture can be shown to be greater than that of trephining; (4) the transcallosal puncture has in a number of cases failed in preserving function. He frequently observed that rapid disappearance of the swelling with marked atrophic pallor and destruction of visual acuity preponderated in the cases in which already diminution of function had taken place before operation.

. . . .

It is certain that transcallosal puncture may also fail even where function has been normal. In conclusion, he considers that while this method cannot be regarded as replacing trephining it still can have a useful function in combination with it. In the subsequent discussion, we are glad to see that Axenfeld refused to accept the dogmatic position taken up by von Hippel, and stated that he felt quite justified in delaying operation so long as the visual function was not seriously interfered with. We feel sure that in this matter the bulk of English neurological opinion is with Axenfeld, and that in the absence of definite neurological indications for operation we are not justified in recommending patients to undergo the serious risks of intra-cranial operation until at least there is evidence of commencing visual loss. (Abstract by Leslie Paton, *Ophthalmic Review,* April, 1913, p. 149).

Aside from the interest that attaches to choked disc as a general symptom of brain tumor, and in less important degree to the anomalies of the visual field, the focal disturbances indicative of implication of the chiasm, pituitary body, third, fourth and sixth cranial nerves, quadrigeminum, occiptal lobes and cerebellum are of immense significance to ophthalmologists. The medical and surgical therapeutic possibilities applied to so wide a range of symptoms require some detailed comment.

Medical treatment. (a) Casual. If it is known or strongly suspected that the tumor is syphilitic, specific treatment becomes imperative and urgent. In brain tumor the inunction plan (Schmierkur) may be used and with good success, but if rapid mercurialization is desired to suppress fulminating signs and symptoms, the deep intramuscular injections are to be preferred. The symptoms of vesperal headache, somnolence and fleeting paralyses should yield in from two to four weeks after beginning the Schmierkur treatment.

If after four to six weeks of vigorous treatment no improvement takes place, the idea of a syphilitic lesion should be abandoned.

Potassium iodide should always be adjunctive to this treatment, with the caution to give same in ascending doses until two hundred to three hundred grains, if necessary, are taken daily. There is a widespread preference among neurologists for the saturated solution in increasing drop doses, but when badly borne, iodonucleoid or iodalbin may be substituted (*vide* syphilis). Massive doses of iodide, except in rare instances, need not cause gastric distress if sufficiently diluted. I frequently give the full daily dose of three hundred to four hundred grains in a quart of milk (if so great a dilution is necessary), and let the patient drink of it at intervals, so long as he gets the quantity prescribed for the twenty-four hours. Ordinarily, it may be taken either before or after meals.

Particular care of the mouth and teeth will prevent salivation: ℞: Pulv. potassi chloratis, ʒii; Ol. cinnamon, m. x., rubbed up well, with directions to use same as a tooth powder after meals, will assist in keeping the teeth and gums in good condition.

The routine use of mercury and iodides in non-syphilitic tumors is to be deprecated because it is useless, although some instances of ''apparent'' improvement have followed its administration.

Symptomatic treatment. 1. Headache. The coal tars, such as phenacetine, acetanilid, and antipyrine, in liberal doses, ten to twenty grains at a time, will relieve; pyramidon in five grain doses does good, but for intractable severe cephalalgia I have found nothing to equal codeine by mouth in one grain doses, often repeated, and later morphine, also in large doses, since small ones never suffice. If the growth is inoperable, then one's conscience need not trouble about developing in the patient a habit for morphine or opium. Ice-bags or hot fomentations to the head may afford some relief. 2. Vomiting, when not controlled by ice pellets taken internally, counter-irritation to the epigastrium, or sodium bromide in large doses, is only relieved by morphine. 3. Sleeplessness. Long-continued warm baths may be tried, and the hypnotics, veronal, isopral, trional, sulphonal, paraldehyde, chloralamid, and finally opiates should be given. 4. Convulsions (epileptiform) may yield to massive doses of bromides, but not for long. 5. Apoplectic attacks and paralyses must be treated symptomatically as they occur. 6. Optic neuritis: Strychnin nitrate, gr. 1/30 to gr. 1/15, hypodermically, has given temporary improvement and similar betterment in vision has followed the use of potassium iodide.—(D. H.)

Lezenius (*Klin. Monatsbl. f. Augenheilk.*, p. 340, 1907), has for the past seven years treated a number of cases of optic neuritis of obscure origin by *hydrotherapy*. The patient was first immersed in a warm bath (29° R. or 97° F.) and while in it cold (15° R. or 71° F.) water was poured on his head. He was then, without being dried, covered with warm clothing and placed in bed. As soon as reaction set in and he felt warm all over he was allowed to get up. This treatment was kept up for weeks at a time and applied twice daily. In every instance the patient was benefited; the headache and vision measurably improved.

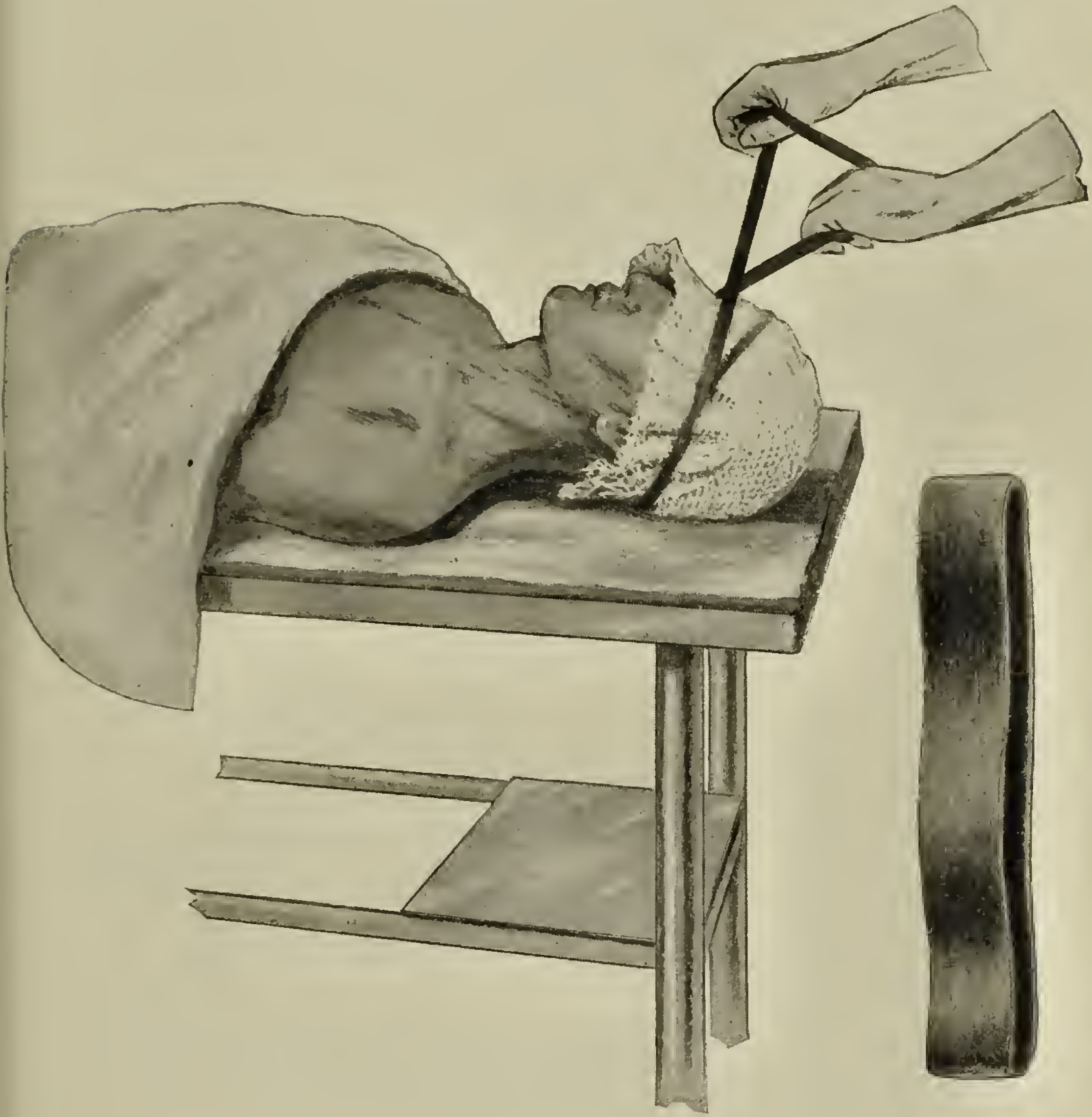
It appears to me that such simple and effective therapeutic measures might well be employed as an adjunct to other treatment, not only in cases of doubtful origin, but in those whose eitology is pronounced.

Operations for the relief of choked disc. Decompression and exploratory procedures.—Since almost every operative procedure on the cranial vault has exploration more or less directly as its aim, and since where exploration fails to detect the disease *decompression* relieves the symptoms, we find this particular operation the most frequently performed and important in our work. Brain puncture, tumor removal, abscess drainage, removal of blood clots, control of hemorrhage, drainage of the ventricles, etc., may be combined with it. Therefore, together with its modifications, it includes nearly the entire field of cerebral surgery.

The conditions for which it is commonly done are the following:—(1) Tumor cerebri, localizable and not localizable, and particularly when associated with choked disc and pressure symptoms; (2) brain abscess; (3) intracranial hemorrhages; (4) hydrocephalus rarely, unless associated with brain tumor. Usually brain puncture is done here in preference to craniectomy. (5) Brain syphilis which does not yield readily to specific treatment; (6) encephalitis in some cases when associated with increased tension and causing optic neuritis or choked disc; (7) edema of the brain in uremia has been considered an indication by Cushing (Cushing and Bordley. Subtemporal Decompression in a Case of Chronic Nephritis with Uremia. *Am. Jour. Med. Sc.,* Oct., 1908, pp. 484-504), but is a doubtful one; (8) in general, any condition associated with increased intracranial pressure and swelling of the optic disc demands for the relief of pressure symptoms and optic nerve changes an exploratory operation, which may be later turned into a remedial operation whose character will depend on whatever pathological condition be found; or into a decompressive or palliative operation if nothing accessible be found.

Preparation. In my clinic, on the day before the operation the patient's head (whole head, if a man; something less than half the head, if a woman) is shaved, scrubbed with tincture of green soap on gauze, rinsed with sterile water, then with alcohol, and then with 1:1000 bichloride. A dry dressing is then applied. This procedure is again repeated on the operating table before the operation.

A double layer of gauze (either dry or wet and wrung out of a solution of 1:1000 bichloride) is then applied to the entire cranium and over this the rubber constrictor. As a rubber constrictor, I use an India rubber band, one inch wide and eight inches in circumference, which can be obtained of any house handling rubber goods. I make two or three turns with it around the head, which I find is constriction enough. There is no buckle to fasten; it never slips; so that tapes, as used by Cushing are unnecessary, and the cost is a few cents only. The patient is then ready for the initial incision.

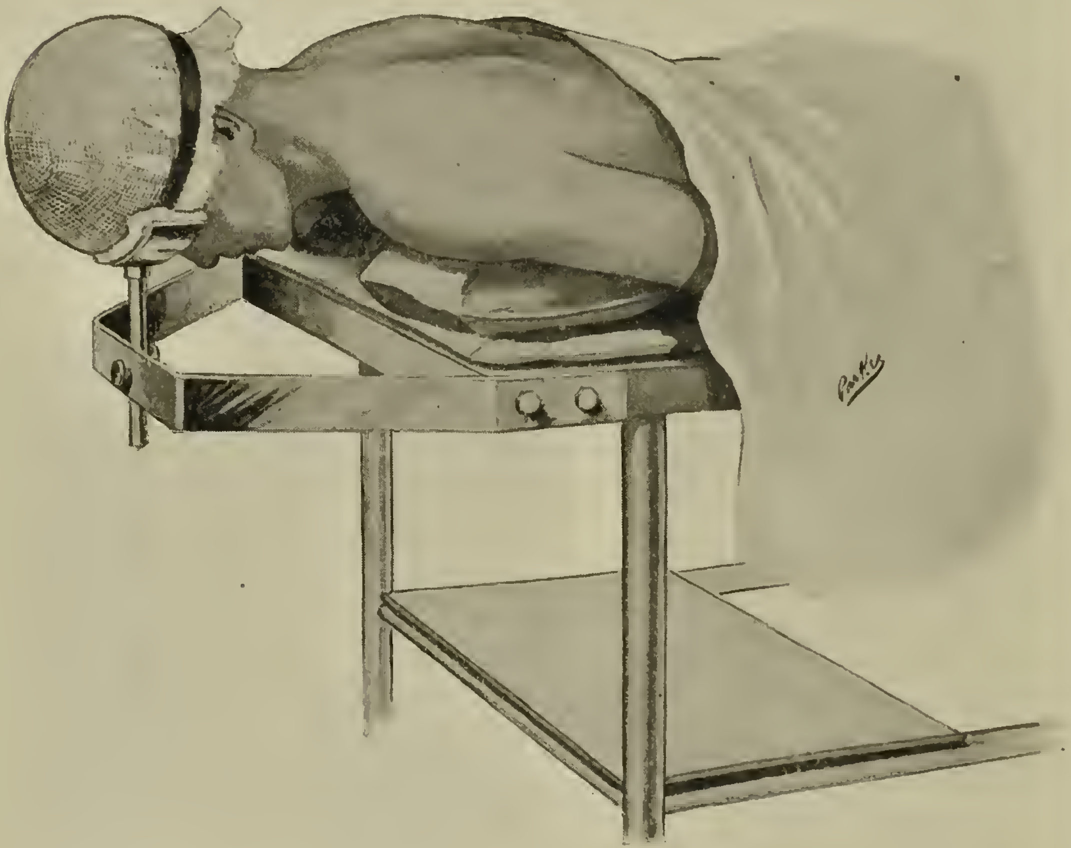


Author's Method of Controlling Hemorrhage from the Vessels of the Scalp by means of a Large Rubber Band.

Anesthesia. Before the patient is brought to the operating room he is given a hypodermic of morphine, ¼ grain; atropine, gr. 1/100, or if the patient be small, or a woman, 1/6 and 1/150 gr., respectively.

Ether, by the drop method, is, as a rule, the anesthetic of the entire operation. But in some cases, especially when for one reason or another speed is necessary, the anesthetic is started with nitrous oxide and oxygen.

Position of the Patient. For temporal and motor area operations and in general for all operations on the anterior half of the cranium, the patient lies on his back, with head and shoulders raised, and anesthesia is employed as for any other operation. The operator and his assistants are, however, separated from the anesthetist by the laparotomy sheet, which is held up between the field of the operation and the field of the anesthetist by an outrigger attached to the table.



Curtis-Halstead Table (St. Luke's Hospital, Chicago). Sandbags under the shoulders; outrigger for the forehead. Gauze over the head secured by a Halstead rubber band.

For suboccipital operations and frequently for any operation on the posterior half of the cranium, the anesthetic is given and the operation performed with the patient lying on his face, the forehead supported on a head-rest in the form of a bracket attached to the head end of the table; with sand-bags under each shoulder, to leave the chest relatively unrestrained for breathing.

The anesthetist sits on a low stool and is covered by the laparotomy sheet drawn over the patient's head. The anesthetist, for his own comfort, wears a rubber cap and a rubber apron, closely tied about his neck, to protect his clothing.

We do not believe in further incommoding our anesthetist with a phonendoscope, as recommended by H. Cushing (Some Principles of Cerebral Surgery, *Jour. A. M. A.*, Jan. 16, 1909, LII, p. 187), unless it be impossible to secure another assistant especially for the purpose of watching pulse and respiration. The extra assistant is easily obtained in any large hospital, and the anesthetist has his hands fully occupied and is in discomfort enough without being put to this extra inconvenience.

Occasionally the Matas apparatus is used. Air saturated with chloroform vapor is led into the patient's retronasal space by means of a rubber catheter introduced through the nose. When this apparatus is used the patient is put to sleep by the usual mask method, and just before the operator is ready to begin, the nasal catheter is inserted and anesthetic continued with the apparatus. The anesthetist is thus completely removed from the field of operation. Because only a relatively small amount of anesthetic can be administered by this method, it is usually desirable to use chloroform instead of ether, especially with large and fat patients and alcoholics.

The incision is usually marked out on the scalp with iodine just before the double layer of gauze and the tourniquet are applied, so that the still wet iodine stains through the gauze. In locating the incision measurements are usually dispensed with. The eye of the surgeon who is constantly employed in cranial work becomes as accurate as any of the craniometers on the market, and it is, moreover, always easy to enlarge the opening in any direction subsequently desired. The incision is semicircular, to form a flap with the base in the direction of the blood supply. The first cut is made down to the lamina externa.

At this point there is always some little hemorrhage from the vessels of the galea, but it is usually easily controlled by (1) promptly turning the flap back and exerting pressure on it, provided that an osteoplastic operation is not to be done; (2) by catching and twisting with sharp Kocher forceps, or ligating the "spurters" with fine catgut, No. 1; (3) by pressure by an assistant with gauze along the margins of the incision. If the rubber tourniquet is used, the hemorrhage is insignificant.

The other measures sometimes recommended for stopping this hemorrhage we have never found necessary to use, and believe that in this we are sustained by the best American practice.

The running stitch of Jacob Frank, of Chicago, later modified by Heidenhain, and known abroad by the latter's name, would be useful, but is scarcely necessary even though the tourniquet be not used, as, for example, in suboccipital and subtemporal decompressions. To keep these stitches in place for eight to ten days, as Heidenhain recommends, seems to us not only unnecessary, but even dangerous to the health of the flaps, and certainly predisposes to slow healing of the wound, and, therefore, frequent loss of cerebrospinal fluid.

Kredel's plates we have even less use for than Frank's ingenious stitch.

Attacking the bone. If an osteoplastic resection is to be made, we proceed at once to bore through the skull. If merely a decompression is desired, we first strip back the periosteum with the skin flap.

Bone instruments. We have tried them all and have come back to the trephine or Hudson burr, supplemented by the De Vilbiss forceps. All electric-driven machinery we have discarded—burrs, drills, rotary saws, etc. They are all wrong in principle because they open the skull from without inwards and therefore expose the brain to injury from excessive penetration and bone splinters. They are all liable to slip at times, even in the hands of the most experienced men, as our dental colleagues can testify, and cut undesired gashes in the bone and scalp. Moreover, their greater speed is largely offset by their liability to get out of order, thus causing long delays, and leading to faulty asepsis. Again, they are impossible to sterilize in toto and slipping towels in the course of long operations are apt to leave non-sterile parts exposed to the surgeon's touch.

The mallet and chisel we have discarded because (1) of the time consumed in entering the skull, and (2) for the reason that we believe the repetition of blows upon the skull may possibly, as claimed by many, produce cerebral concussion.

I have been very well pleased with the Hudson burr. Its chief value is not the rapidity with which it can be operated, but in its mechanical construction, which is so adjusted that when the teeth of the burr strike non-resisting dura they cease to bite, thus making injury to the dura and underlying brain impossible, even when considerable manual force is applied.

The trephine opening is made large enough to admit a De Vilbiss cutting forceps and with the latter the bone incision is enlarged in the direction of and parallel to the skin incision, or as desired, but keeping well inside the latter, in order to avoid overlapping of the bone and galea incisions. If an osteoplastic flap is to be made, the bone incisions are continued around to the narrow base of the flap, which is then broken across by prying the flap with a bone elevator and perhaps also making cuts at the sides with a special chisel. (See illustration.)

Where an especially accurate reposition of the flap with avoidance of pressure on the dura is desired, a Gigli saw may be passed from one trephine opening to the other and the intervening bone sawed through on a bevel. A Braatz sound or similar dural separator and protector must be passed between dura and lamina interna and along this, as a guide, the Gigli saw is passed and manipulated. I do not use the Gigli saw method, however, because of the ever-present danger of damage to blood vessels and brain in passing the sound and saw and in making the first few strokes. The method also has the disadvantage of being somewhat slow.

When it is desirable to enlarge the bony opening, a new flap may be made with the De Vilbiss forceps, or bone may simply be bitten away in the desired direction with the Macewen rongeur forceps.

Hemorrhage from the bone has now to be controlled and this is done by (1) pressure with gauze wrung out in hot salt solution and packed tightly against the bone; (2) packing the oozing bone with Horsley's wax or with muscle tissue from the cut galea; (3) acupuncture with any pointed instrument and mallet. A simple orange stick is cheap, easily sterilized and applied; (4) crushing of the bleeding bone with the rongeur forceps is usually successful if other methods fail.

Hemorrhage from the dura and cerebrum occurs only when these are wounded, a rare occurrence with our technic. Occasionally a vein runs from the dura into the lamina interna of the cranial vault, and this may be cut through in the incision, but the resulting hemorrhage is controlled by ligating the vein on the dural side.

The dura now lies exposed before our eyes. By palpation with the finger-tips we estimate its tension, and whether it pulsates or not.

Where tension is much increased, marked pulsation is usually absent (depending on the relation of the intracranial tension to the blood pressure). Also we must feel for any increase in local resistance, such as would indicate a tumor or infiltrate; or for signs of fluctuation, due to intracranial fluid or cyst formation.

The incision in the dura is next made. This may be either (a) cross-shaped, or a (b) flap, the pedicle of the flap being placed either (c) in the direction toward which further exploration and chipping away of the bone is to be done, or (d) in the opposite direction from the skin flap pedicle, to have an overlapping of the two flaps on closure of the wound, and thus prevent a brain prolapse and subsequent fungus cerebri.

When the pia-arachnoid lies exposed, a careful examination is again made. Pulsation is looked for; dilated blood vessels are duly noted, as an indication of an adjacent tumor; likewise differences in color, prominence and smoothness of the surface. Any local tendency to obliteration of the sulci or flattening of the convolutions is regarded as an important localizing point. Palpation with the finger-tips of both hands is done to determine possible spots of increased resistance or fluctuation.

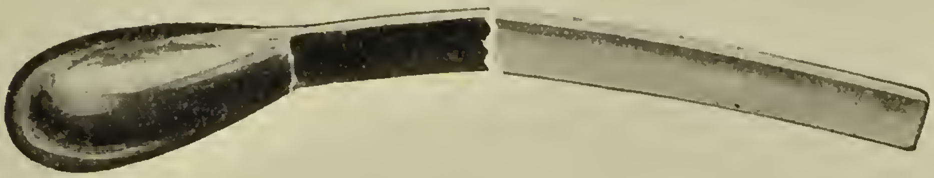
Exploratory puncture is then made into suspected areas and the tissue brought away by the needle is examined macro- and (at times) microscopically, to determine the presence of fluid, pus or tumor tissue. The search for brain-tissue cylinders by needle puncture, as recommended by Krause, we have found of not much value, and believe it to be dangerous.

Fenger, of Chicago, some years ago gave this method a considerable trial and invented a special needle for it, provided on one side with a slot with sharp edges. The needle was inserted into the brain, then turned around to cut out the cylinder of tissue. Fenger finally abandoned the procedure, however, owing to its dangers and unreliability.

Exploratory puncture for pus. We never make this through the dura; only after the membrane has been opened and the subdural space walled off by packing with several layers of iodoform gauze. (See illustration.) When this is done, the needle is inserted, and as soon as the pus pocket is located an artery forceps is inserted along the side of the needle into the cavity. The blades of the forceps are then spread as they are withdrawn, and thus a large opening is made, with probably less damage to nerve fibers and blood vessels than when a knife-blade is used. The cavity is then irrigated, usually with normal salt solution, and packed with iodoform gauze. During all these manipulations the subdural space is kept well walled off with the iodoform gauze, the outer layers of which are renewed when the irrigation is complete. Drainage to the exterior is then made by a knife thrust through the flap directly over the opening to the abscess cavity, and here the drain, either cigarette, spiral, or split rubber tube, is led out.

Closure of the wound is done in layers, with buried stitches of catgut and superficial stitches of silkworm gut. The dura is brought together and, when possible, the edges overlapped, unless decompression is aimed at, when it is left unsutured. Sutures are of No. 1 or 2 iodized catgut.

The bone flap is replaced, attached to the galea, but no sutures inserted in it. Periosteum, unless much stripped up, is left unsutured. Tension stitches of heavy silkworm gut are now inserted into the galea flaps and between them approximation stitches of light or silkworm gut.



Krause's Flexible Sound for Exploration of the Subdural Space.

The wound is first washed with bichloride, 1:1000, then with alcohol, and finally sealed with tincture of benzoin and silver foil; or, less frequently, with collodion on narrow gauze strips. Fluffed gauze is then applied over the wound and, later, a ''doughnut roll'' of gauze is placed around the wound to protect the bony flap and brain below it from external pressure. Over the whole bandage a large combination is then applied, and, lastly, a roller bandage held with adhesive strips.

Stimulation of the patient. Before the operation the patient's left cubital space is prepared so that an intravenous infusion of normal salt can be given instantaneously, if necessary. A hypodermoclysis apparatus for simultaneous administration of normal salt under both breasts at once is in readiness during the operation.

A hypodermic of thirty minims of camphorated oil, or 1/100 gr. digitalin, is given usually before the patient leaves the table, if any evidence of shock or collapse be present, and he is put to bed with his head low. On returning to consciousness, the patient is allowed to suck ice, or is given teaspoonfuls of hot water, whichever he prefers. Normal salt enemata of a pint each are given at intervals of four hours for thirst and for purposes of stimulation. Continuous rectal administration of normal salt solution I have never found as satisfactory as its administration at intervals, owing to the inconvenience the tube causes the patient and the constant soiling of the bedding.

If post-anesthetic vomiting is prolonged over twenty-four to thirty-six hours, the stomach is washed out with a couple of quarts of warm water, which usually gives prompt relief. When vomiting has ceased, the patient is put on liquid diet, and, if convalescence is normal, a couple of days later on light diet, and at the end of the first week a general diet is allowed.

If there is considerable seepage of cerebrospinal fluid after the operation, the outer dressings are changed as often as saturated, and the inner dressings daily. Any stitches around which necrosis is threatening are removed at the daily dressings and necrotic tissue is promptly clipped away. Tincture of benzoin is applied to the cut surface, and is usually swabbed over the whole wound at every dressing.

When dressings must be frequently changed, they are retained by a large figure-of-eight bandage instead of the roller.

Where there is no discharge of the cerebro-spinal fluid, the dressings are not removed until the end of the first week, at which time the stitches are taken out, tincture of benzoin swabbed over the wound and the dressing reapplied for another week, at the end of which time it may be left off entirely. As long as cerebro-spinal fluid continues to discharge, careful aseptic dressing must be continued. Use of the silver nitrate stick and tincture of iodine swabs hasten the closing of these fistulæ. Not infrequently they occur through a stitch puncture, especially if the stitch be left in too long. For this reason we often remove stitches as early as the fourth day, if the wound is well united, but usually from the fifth to the seventh day.

Occasionally a patient will suffer pressure symptoms when a long open fistula finally closes. In such cases it must be reopened and then again gradually allowed to close.

Patients are usually allowed to sit up on the third or fourth day and leave bed at the end of the first week.—(A. E. H.) See, also **Brain tumors.**

Observations on the *results of the operative treatment of choked disc, especially by the trephining-decompression operation* have been well presented by de Schweinitz and Holloway (*Trans. Coll. of Physicians,* Phila., 1908), under the following captions:

1. The earliest date at which subsidence of the swollen disc is noticeable.

In eleven cerebellar tumors recently observed, the first distinct lessening in the disc edema after operation, that is to say, at least 1 D. was noticed as early as the end of the first day in one case and deferred as late as the twenty-third day in another case, the average being a little over nine days. A similar analysis of nine cerebral tumors showed that the first decrease occurred in one case as early as the end of the second day, and in another case, in which there was a primary increase of the edema, it was delayed to the thirtieth day, the average being a little over ten days. A very common result, even in those cases in which the disc edema itself does not appreciably diminish for the first few days, is a lessening of the general vascularity of the eye-ground, which is often quite noticeable within a few hours after the trephining, although they were not able to observe it while watching the eye-ground during the progress of the operation. This, however, is rather difficult to do, and doubtless future investigations along these lines may yield other results. In general terms, it may be stated that while the disc edema may subside as much as 1 D. within the first twenty-four or forty-eight hours, and quite commonly begins to subside from the third to the fourth day, an average of a number of cases usually indicates that the first distinct improvement occurs from the ninth to the tenth day. This observation is in accord with the statistics already published by Paton, who states that generally within a week or a fortnight after the second operation (all of his cases were submitted to two operations; or, rather, to two stages of operation, the first consisting in removal of the bone and sometimes incision of the dura, and the second, if possible, the removal of the tumor itself) there was distinct subsidence of the swelling, but between the two operations there was little measurable alteration in the discs.

According to Marcus Gunn the date of the first occurrence of the subsidence of disc swelling and the rapidity with which it proceeds vary considerably, but are earlier and more rapid in cases where the operation has been performed not later than the third stage of disc edema. They did not find in their observations that there was any material advantage, in so far as the preservation of restoration of vision was concerned, in sudden subsidence of disc edema, or, more accurately, in rapid subsidence, with perhaps one notable exception, operated on at the Orthopedic Hospital by Dr. Taylor. Indeed, they have come to believe that the more gradual subsidence, beginning at about the tenth day, yielded more favorable results than when the disc elevation subsided more rapidly. This point, however, is one which would require further study before it could be presented in a dogmatic statement.

2. The indications which the disc appearances give as to the size and situation of the growth; that is to say, whether it is on the right or left side of the brain or cerebellum.

As has been pointed out many times by various observers, ophthalmoscopic examination yields no information in regard to the size or structure of a tumor, because it is perfectly well known that small growths may cause an elevation of intracranial pressure greater than large and infiltrating ones, depending upon the situation of each. If the growth has caused an increase in intracranial tension through what has been called the intermediation of an internal hydrocephalus, as Bordley and Cushing point out, the disc edema is apt to be equal in the two eyes, and it is probable, as these authors further maintain, that if every brain tumor exerted its pressure equally in all directions the swelling in the two discs would always be likewise equal. This we know is not always the case; and, moreover, under certain circumstances there is a greater pressure of fluid in the optic nerve sheath on one side than the other, and therefore a greater swelling of the optic disc in one eye than the other. Whether this greater swelling on one side is a sufficient indication that the growth is also upon the same side of the intracranial contents is a matter of dispute. Thus, Sir Victor Horsley holds that the disc edema, or neuritis as he calls it, occurs first of all, or is more intense, on the side of the tumor, while Leslie Paton's observations indicate that no reliance can be placed on this sign, for although the preponderance was somewhat in favor of the more severe neuritis being on the affected side, yet in some cases it was more marked on the opposite side. On the other hand, Sir William Gowers and Beevor, agree with Horsley in regard to the homolaterality of the disc swelling and the tumor. Touching this point, Bordley and Cushing state that in 70 per cent. of their cases the papilla on the side of the tumor was the most involved, and in 80 per cent. of the cases seen before the choked disc made its appearance the first swelling ultimately occurred in the eye homolateral to the tumor, and in 72 per cent. the ultimate damage to the nerve was greatest on this side.

In the majority of cases observed by de Schweinitz and Holloway, the greater swelling was on the same side as the tumor, but they would agree with Horsley, Cushing, and others, that it is not so much to the swelling of the disc that attention should be paid as to the indications as to which disc has been longest affected by finding the evidences of beginning atrophy, by attention to which side of the disc has first been affected, the nasal or the inferior quadrant, and by the information which is given by a test of the visual acuteness, the light sense, and the field of vision. As Bordley and Cushing point out, a tumor may, for instance, be present on one side of the brain, and by the character of its growth impinge on the opposite side and cause an unequal forcing of cerebrospinal fluid into the intravaginal sheath of the optic nerve, and therefore a greater swelling of the disc on the opposite side of the tumor; or it may happen that the examination is made when the disc which was originally the largest in size had already begun to decline, and this would throw an element of doubt on the examination. Therefore, the mere swelling alone does not furnish the most important information, but the other symptoms, to which attention has been called. So sure of this is Sir Victor Horsley that he states: "Within my own knowledge the early failure of visual acuity indicates beyond doubt the situation of the tumor." The essential point, according to him, is the estimation of the age of the neuritis, and this means minute examination of the interstitial tissue of the disc.

3. Delay in the development of the optic disc changes.

It has already been stated that there is some reason to believe that a study of the refraction of the eye is of some importance in the determination of this point, and that although all observers are not in entire accord, there is a good deal of evidence to show that in the presence of myopia the disc changes do not develop as quickly as when the other type of refraction is present.

A still more interesting question in this connection is the age of the patient, and if Singer's tables are correct, the absence of optic neuritis, or disc edema, in intracranial tumors, exclusive of those occurring in the pons, is rare in cases under forty years of age and becomes increasingly more frequent after that period of life. Thus in an analysis of 88 cases of cerebral and cerebellar tumors, he found in 35 cases under thirty years of age well-marked choked disc in 97.1 per cent. of the cases, and its late or slight development in only 2.9 per cent. of the cases, it being absent in none of them. Between thirty and forty the figures read thus: 18 cases, well-marked neuritis, 76.6 per cent.; late or slight neuritis, 2.2 per cent.; absent, 1.1 per cent.; between forty and fifty the neuritis was well-marked in 61.9 per cent. of the cases, 21 in all, and absent in 19; while over sixty years of age in 7 cases it was not well-marked in any of them, late or slight in 14.3 per cent. of them, and absent in 57.1 per cent.

The most satisfactory treatment for the purpose of preserving vision in any case of choked disc or papillo-edema not due to a toxic process or constitutional disease ("infectious optic neuritis"), but depending upon increased intracranial tension, is decompressing trephining, with the removal of the growth if it is accessible.

This operation should be performed early, and if it can be done during the first, second, or even third stage of papillo-edema, the prognosis as to sight is most favorable.

If for any reason the operation is postponed until the development of the fourth and fifth stages of papillo-edema, already associated with marked depreciation of vision, the prognosis as to sight is unfavorable; but, even under these circumstances the operation should be performed, because it sometimes preserves such vision as still remains, and if it should happen to be followed by a rapid depreciation of vision, as, unfortunately, is apt to occur, it at least gave the patients a chance, because without it they are doomed to blindness.

The investigation of the eyes under these circumstances must include not only an ophthalmoscopic examination, but one which includes a careful investigation of the visual field, the color perception, light sense, size of the blind spot, etc.

Patients afflicted with papillo-edema dependent upon increased intracranial tension should have the case fairly stated to them, and the operation should be urged in spite of occasional unfavorable results, because in its absence ultimate blindness is almost sure to result.

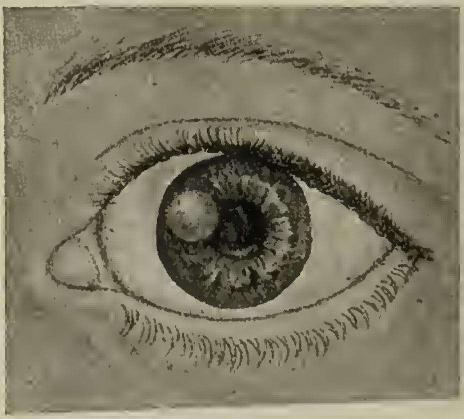
Orlandini (*Annali di Ottalmologia,* xl, 1913, p. 283), reports that in a number of such cases in which a surgical operation was done, either for decompression or removal of the tumor, ophthalmoscopic observations were made (1) immediately after trephining and before incision of the dura mater; (2) in the period between the primary trephining operation and the secondary one for excision of the tumor, and (3) during the further progress of the case, either till death or recovery. After trephining without incision of the dura mater the changes were usually inappreciable. Where a tumor was removed, the results as regards choking of the disc varied from practically none to rapid reduction of swelling. In one case a pronounced network of fine vessels on the disc disappeared rapidly after removal of a tumor of the occipital lobe. On the basis especially of this case, as well as of the fact that papillary stasis is sometimes confined to one side, the author favors the mechanical as against the inflammatory theory of causation. In his own cases the most marked swelling occurred where the tumor made pressure on the sinuses.

Cholera. Although this fatal and contagious disease has not invaded North America for many years, and the eye symptoms are not likely to be of special interest to us, yet it may be said here that the account given by Lawford (*System of Diseases of the Eye*, Vol. 4, p. 712), of the ocular lesions dependent upon the various forms of cholera, is the best discussion of the subject in the English language. The following account of it is taken almost *verbatim* from the chapter referred to. He reminds us that the causative agent of cholera nostras and cholera infantum although not due, as in Asiatic cholera, to the comma bacillus of Koch, yet yield, although in a minor degree, many of the ocular signs and symptoms of the more serious disease. In grave forms of cholera it is noticed from the first moment that the skin of the eyelids is bluish (cyanosis), and that upon account of difficulty in closing them they appear half open. If the patient is asked to close them, he can do it, but they soon open again. This is not only on account of weakness of the orbicularis muscle, but also because of contraction of the cellular tissue of the orbit, which causes the eye to retract, thus allowing the muscle to lose its point of support. The lachrymal secretion is considerably diminished, so much so that, no matter how intense may be the pain experienced by the patient, he never weeps. According to von Graefe the dropping of an irritating substance on the conjunctiva—laudanum, for instance—fails absolutely to provoke any hypersecretion of tears. During the asphyxic period of the disease the patient turns his eyes upward, so that either only a small portion of the cornea can be seen or else it is entirely covered by the upper eyelid. The bulbar conjunctiva, therefore, remains partly exposed, causing it to dry and become injected. Under these conditions Josreph has observed an ecchymosis which he believes is of fatal prognostic significance, for in twelve fatal cases the symptom was not slow in appearing. Towards the end of the algid period a certain opacity which has not been covered by the upper eyelid has been observed in the superior portion of the cornea. If life is prolonged for one or two days longer, a superficial detachable eschar of a dark hue appears. The rest of the cornea, which up to this time has maintained its transparency, rapidly suppurates. Graefe admits that the keratomalacia observed in cholera is of neuro-paralytic nature, but Berger believes that desiccation unquestionably plays an important *rôle* in its pathogeny. In grave cases of cholera the sensibility of the cornea is notably diminished. The existence of this condition has been confirmed by Campart and Saint-Martin. The appearance of blackish spots in the sclerotic is a most unfavorable symptom. They are situated around the lower part of the border of the cornea. Their form is irregular and they are disseminated; but at times they coalesce and constitute but one area. Boem and Graefe recognize in them the effect of desiccation of the sclera, which appears at a point that is situated opposite a similar area in the bulbar conjunctiva. Graefe has seen these spots make their appearance in the lower eyelids. Up to the present time their exact pathogeny is unknown, as no pathological examination of them has even been made. Enophthalmus is also very pronounced in the algid period of cholera. This is due to a considerable diminution of liquid in the retro-bulbar tissues. It is not, however, in this disease only that the orbital cavity becomes empty in this manner, the phenomenon having been observed also in certain tumors. Delens mentions the case of an individual suffering from adenitis who had lymphatic tumors in the submaxillary region, the hard palate, and the pharynx, with axillary infarction. The orbits presented two symmetrical tumors of considerable size, which had grown in a period of from fifteen days to three weeks. Each tumor, which was indolent in nature, was of the size of a walnut, and elevated the upper eyelid. Vision was intact. Microscopical examination of the blood showed a considerable increase of the white corpuscles. The diagnosis of adenitis with lymphadenoma of the orbit and of the hard palate was made. Subsequently the patient was attacked with cholera and recovered. Fifteen days later the tumors of the orbit and of the hard palate had disappeared. The submaxillary tumors remained, slightly infarcted. The axillary and inguinal swellings were reduced considerably in size. During the algid period Graefe has found the pupils contracted. At the commencement of the disease they are dilated. Compart and Saint-Martin have frequently observed such dilatation. Graefe asserts, with sufficient reason, that the myosis seen during the algid period is produced by paralysis of the cervical sympathetic. The writer believes that a lesion of the sympathetic contributes to the retraction of the eyeball. Jacobson attributes the enophthalmus either to mechanical causes or to alteration in the blood or in the vessels. He does not, however, venture upon a thorough explanation of the question. Bouchard thinks that the myosis is the effect of auto-infection which results from the accumulation of toxic products in the economy by reason of lesion of the kidneys, which prevents these organs from eliminating them. The result of his experiments, however, which consisted in injecting the urine from cholera patients beneath the skin of animals, refutes this theory; for, although he produced the symptoms of cholera in these animals, he did not obtain myosis. During the epidemic of 1885 in Marseilles, Coste, while examining patients, observed that in the algid period the pupils were extremely variable in size. As these apparent pupillary conditions furnished him only contradictory indications of prognosis, he endeavored to find more certain types of pupillary reflex. From observations gathered from one hundred and twenty-seven patients each of whom he studied on an average for twenty-four hours, he arrived at the following conclusions. In the algid period of Asiatic cholera the state of the pupils, whether normal, contracted, or dilated, does not furnish any data towards forming a prognosis. The same rule, however, does not hold good regarding the pupillary reflex. When the reflex is present, the prognosis is favorable. When it is absent, the disease is fatal. In other words: 1. Whenever during the algid period of cholera, even though there be marked cyanosis, the normal or contracted pupils are susceptible of motion, one may form a favorable prognosis; or, what amounts to the same thing, if the pupils dilate on placing the eye in the darkness resulting from lowering or closing the eyelids, and return to their original diameter when exposed to the light, it may be said that the patient will escape this period, without being on this account protected from the relapse or from the complications of the period of reaction. 2. From the moment when the pupils are contracted and immovable, it may be asserted that the patient will succumb during the course of this period; this, he says, is true in spite of slight gravity in other symptoms, and even when the re-establishment of certain functions would seem to point to a happy termination. 3. If the dilated pupils are immovable (do not respond to the stimulus of light), the prognosis is likewise fatal; here the case will terminate fatally in the course of this period. 4. When the pupils are sluggish, one may prognosticate a slow recovery of the patient, or perhaps that the duration of the recovery, independent of complications, will be proportionate to the pupillary activity of the algid period. 5. When the pupils are unsteady, it may be inferred, in spite of the slight gravity of other symptoms, that the pupils will finally contract and become immovable, and therefore that the patient will succumb during this period of the disease. The appearance of this pupillary sign, therefore, indicates, at least, paralysis of the reflex. In general, he says that if the pupillary reaction is weakened, a prolonged period of convalescence must be expected. To Berger the opacities of the vitreous, and especially of the crystalline, prove that the uveal tract may be affected. Ophthalmoscopic examination of the fundus of the eye during the algid period shows that there is a contraction of the retinal arteries, whose color appears of a dark red. In such cases slight pressure on the ocular bulb is sufficient either to provoke an arterial pulse or to exsanguinate the vessels of the fundus. These phenomena are considered to be the consequence of debility of the cardiac muscle and diminution of intraocular tension, this probably being dependent upon perturbation of the sympathetic. At the same time they are observed with the disappearance of the second sound of the heart and of the radial pulse. Contrary to what is observed in the arterial currents, the retinal veins retain their normal diameter and contain very dark blood. At times Graefe has observed the blood-currents to be interrupted in the veins of the retina. He has also seen the movement of small bloody cylinders in the retinal veins, as may be observed in some cases of embolism of the central artery of the retina. Reference has already been made to the haziness of vision of which some patients complain at the beginning or during the course of the algid period of cholera. It is not known yet whether this ought to be attributed to weakness of the blood-currents or to ocular disturbances which have originated from the presence of microbes or their toxic products in the economy. Suppression of urine, in fact, is very frequent towards the end of the algid period of asphyxic cholera. This type of cholera predisposes to parenchymatous nephritis, which may bring about auto-infection by reason of the substances contained in the urine. Frequently during the period of reaction of cholera a sharp conjunctival hyperemia, which may degenerate into catarrhal conjunctivitis, has been observed. The secondary complications, under the name of typho-choleraic, are lacking in any special influence in regard to the eyes, though Josreph maintains that, except in grave cases, where there is a state of mydriasis, the pupils are always contracted.

Parsons quotes Axenfeld as stating that metastatic ophthalmia has not been definitely observed, although iritis, choroidal hemorrhage, cataract (see **Choleraic cataract**), and vitreous opacities may be sequels of the disease. See, also, **Bacillus choleræ.**

Choleraic cataract. A form of lenticular opacity, probably due to the abstraction of water from all the tissues of the body, including the crystalline, not uncommonly shows itself in the last stage of cholera—a fact that favors Leber's dehydration theory of the production of certain forms of cataract.

Cholesteatoma. A cystic tumor containing a white, shining, semi-solid, fatty substance like stearin or spermaceti. It is often laminated and sometimes contains small hairs and crystals of cholesterin. This cyst



Pearl Cyst of the Iris following Traumatism. (de Schweinitz.)

is most frequently found in the pia mater and sometimes in the subcutaneous areolar tissue. In the eye it more often affects the iris. Implantation cysts of the iris are occasionally due to deposits of cholesteatoma. These "pearl" cysts, as they are sometimes called, are nearly always the result of injury or operation.

Cholesterin. A substance found under its own form in the blood, the brain, nerves, the crystalline lens, the spleen, and the liver. It is a white, glittering, soapy, crystalline compound, forming fine needles and rhombic plates. It is insoluble in water and in cold alcohol, but is soluble in solutions of the bile-salts. It is excreted by the liver with the bile, forming from 0.1 to 0.2 per cent. of the latter secretion. It also forms a large part of gall-stones, and is believed by some to be converted (in the intestines) into stercorine, under which form it is excreted with the feces. Cholesterin is found in many of the ocular organs, sometimes as a normal but generally as an abnormal constituent. It has been demonstrated that it is not an infrequent component of the crystalline lens—although in a state of solution. It occurs in the anterior chamber, in some senile degenerations of the cornea, in hypermature (especially in Morgagnian) cataract, and one of its most brilliant exhibitions is a *synchisis scintillans* —of the fluid vitreous—and, finally, Soelberg Wells describes it as occurring in the optic nerve. In several degenerations of the choroid one sees with the ophthalmoscope these glittering particles. It is also a deposit in a number of intraocular tumors, especially in glioma, for example. In the degenerative patches of this neoplasm (affecting mainly the retina) cholesterin crystals are of frequent occurrence.

Besides the examination under the microscope, when the characteristic notched rhombic plates are readily seen, this substance gives, according to Parsons (*The Pathology of the Eye,* Vol. 2, p. 457), the following reactions: (1) With iodine and concentrated sulphuric acid the crystals give a play of blue, red, and green, finally dissolving. (2) Heated with sulphuric acid and water (5:1) the edges of the crystals turn red. These tests are best performed under the microscope. (3) A solution of cholesterin in chloroform shaken with an equal amount of concentrated sulphuric acid turns red, and ultimately purple, the subjacent acid acquiring a green fluorescence.

Cholesterin cataract. A dense white cataract, usually capsulo-lenticular, containing sparkling crystals of cholesterin, imbedded in the lens substance.

Clausen (*Ophthalmic Review,* April, 1911, p. 127), remarks that cholesterin occurs in the lens with greater frequency as age advances, and its presence is very much more probable where the lens has become cataractous; but that it is chiefly in hypermature or complicated cataract that cholesterin is formed, it being a feature of certain degenerative processes in the lens. Although it is rare to find cholesterin crystals in an immature cataract yet Clausen reports the case of a man, aged 70, whose left eye, which with + 1-75 still possessed 5/15, exhibited pretty copious cholesterin formation in the pupillary area: so numerous were the crystals that they could be seen with the naked eye. Clausen attributed their presence in an eye so nearly normal to the age of the patient, regressive changes occurring readily in his tissues.

Cholesteritis. (L.) A variety of synchysis attributed to crystals of cholesterin detached from the lens and floating in the aqueous or vitreous humor. See **Synchesis scintillans,** and **Cholesterin.**

Cholose américaine. (F.) Yellow fever; diarrhea.

Chondrofibroma. (L.) A chondroma, or cartilaginous tumor containing much connective tissue.

Chondroma. (L.) A neoplasm composed of cartilage. The parts of the eye most commonly affected by it are the lachrymal glands and the orbit.

Chondroma of the orbit. CARTILAGINOUS TUMOR OF THE ORBIT. Enchondroma or chondroma of the orbit was early recognized. Mackenzie tells us that "craggy or semi-cartilaginous" tumors constitute one of three forms of exostosis of the orbit. Soelberg Wells remarks that true cartilaginous tumors (enchondroma) are rarely met with in the orbit. See **Cartilaginous tumors of the orbit.**

Chondrosarcoma. A sarcoma that has undergone cartilaginous degeneration, or *vicê versa.* Nodules of cartilage are found imbedded in the sarcomatous tissue, in which round and spindle cells are also seen. The new growth is distinguished from typical chondroma by a progressive formation of cells that constantly differ more and more from normal cartilage cells. On the disappearance of this basic substance, the tumor may eventually become a round-celled sarcoma. Chondrosarcoma as it affects the ocular apparatus is generally seen in the orbit, although even here it is exceedingly rare. In all probability the few cases reported are secondary tumors by extension from the lachrymal gland. A good account of them, with a histological demonstration, is furnished by Paul in the *British American Journal* for July, 1902.

Chop nut. See **Physostigma.**

Choral-amylene hydrate. See **Dormiol.**

Chord. That part of a straight line which is comprised between two points of intersection with a curve.

Chorda dorsalis. (F.) Notochord.

Chorea, Ocular symptoms of. St. Vitus' dance. There can be no question but that this disease of childhood is accompanied or followed by definite ocular signs. Among these is *blepharospasm,* which sometimes precedes and acts as a danger signal of a general attack. Errors of refraction and muscular defects are said by some to be one of the causes of chorea, and cases of cure of the disease from the wearing of correcting lenses have been reported. In general. the eye muscles are not involved in the choreic movements; only in rare cases do we find unrest or spasm in solitary extrinsic muscles. When present these have the typical, clonic, rapid character of chorea, and may even produce temporary squint with diplopia. In addition spasm may occur in the orbicularis palpebrarum. manifesting itself as nictitation; sometimes as a more decided blepharospasm. In a word, cramp of the eye muscles in chorea behaves quite like cramp of other muscles.

Much more serious are those instances of *embolism of the central artery* (Gowers, *Royal Lond. Ophthal. Hosp. Reports,* 8, p. 181) *of the retina* and *optic neuro-retinitis* that have been published on the best authority. It must be remembered that in many cases of chorea there is also present some form of acute rheumatism with its cardiac and other complications. Ocular conditions arise during the period of attack which may be due to these vascular changes rather than to the chorea proper.

Whether the ophthalmologist treats the choreic symptoms or not, he will remember that the therapy of the ocular distress is involved in the treatment of the general neurosis and that he ought to know the therapeutic measures commonly advised in this often formidable disease. Treatment of the eye symptoms alone is a purely empirical proceeding.

In describing the *treatment* of chorea, one becomes aware of bringing forth little of anything new. certainly nothing revolutionary. Any one of a series of measures has been accepted, which, without being strictly indicated, may be given at some time in the course of the disease. Based upon the literature and a personal observation of a moderately large series of cases, the inference would be justified that cases of minor chorea of moderate severity show no great differences in their duration. whether under a treatment entirely expectant or strenuously medicinal.

Taking them all in all, the mild together with the severe cases, one cannot help but feel that the appropriate treatment for chorea comprehends: (1) Rest and isolation; (2) improved hygiene and nutrition; (3) drugs judiciously used. Disregard for these measures frequently results in a failure to get an ideal cure in chorea, and there often remains the impress of permanent instability upon the general nervous system.

Here, as elsewhere in medicine, rest, ever so respected in the theory, is not sufficiently urged in the practice. The element of complete rest cannot be overestimated in chorea, and especially is this true of its service in the earliest period of the attack. It is quite the logical, the natural thing to advocate it when the twitchings are so severe that there ceases to be an alternative. It is the patients of robust build, florid complexion, with very slight twitchings, who are advised that they may remain up or lie down, or do a little of either. In these individuals, the needful amount of rest is not prescribed. The advice the lighter cases of chorea should receive is, in effect, that theirs is a disorder in which anemia, general malnutrition and endocardial mischief may conspire to inflict irreparable damage, that these sequelæ must not only be anticipated by the physician, but promptly averted, so far as that is possible with rest.

It is always indicated to immediately take choreic children out of school, away from the confinement of the class-room, remote from the atmosphere of intense study and rigid discipline. Above all things, the parent should realize the futility of whipping the choreic child for apparent awkwardness and a display of temper, and be enjoined from inflicting every kind of punishment or restraint. But that is not all. Once removed from school and tenderly treated, the child should not be left to indulge in play as a beneficial form of relaxation.

It is far way from the leisure and relaxation of normal play to rest as it should come to be understood and valued in the treatment of chorea. Here, rest implies emancipation from all kinds of physical and mental excitement. The run-down, pale, irritable, over-wrought, twitching child must be put to bed in a quiet place, be treated by a quiet, unobtrusive individual, in a quiet manner. Left to its own devices, a child restless and not very sick will soon crave entertainment, but such diversion should not be of its own making. It is misplaced kindness to load a little patient down in bed, with games and playthings without number, and have all the neighbors' children in, crowding the sickroom, to help pass away the weary hours. It is imperious to keep the choreic child passive; therefore, it must be read to, talked to, sung to; in short, entertained.

Should rest prove very irksome, as it not infrequently does, thereby aggravating all symptoms, reasonable measures of repose on a couch or reclining chair should be tried, always, however, with an intent to supply the element of amusement. The management of such changes in a long siege of bed rest requires much tact and ingenuity.

Timely rest in the severer forms of chorea may entirely ward off and will surely minimize the danger of the much-dreaded endocardial complications, and its effectiveness in these cases is the greater as we encourage with rest, isolation. In grave instances, the mental irritability, the excitable and exhausted physical state, demand this seclusion.

It is not at all uncommon for the muscular twitchings and bodily unrest to be so great that ways and means of avoiding self-inflicted injuries must be devised by the generous use of mattresses, cushions, pillows and side-bars, padded with cotton. I have seen a child, eight years old, whose seizures threw her violently from the bed to the floor, and for whom this sort of restraint became necessary.

Need I add that every plan contemplating rest should include the consideration of a light, sunny, and well-ventilated room? Warm sunshine should never be at a premium in the sickroom of a choreic child.

Adjunctive to rest, isolation and hygiene, and quite as essential as any of these, is the matter of food and feeding. The diet should be light, non-stimulating, nutritious, easily assimilable, and given in abundance. The latter advice is emphasized not for the reason that these children are deliberately underfed, but accidentally so, owing to the embarrassment they are made to feel by the severe twitchings and incoördination. The giving of liquids is frequently curtailed for the same reason and the insufficiency of fluids, together with an excess of highly nutritious foods, tends to constipation. Tea and coffee are interdicted. All writers are agreed that fats are positively indicated, and, therefore, advise milk, cream and butter in great plenty, but good soups, meat, fish, eggs, spinach, lettuce; in short, the nitrogenous foods, are not to be omitted.

When a patient is given to taking too much farinaceous food, it is very liable to produce excessive flatulency, thereby increasing the sense of palpitation, which may already be severe, from cardiac involvement per se, or the degree of anemia invariably present in advanced cases. I have had occasion to give kazol a fair trial in cases where milk was either not well borne or disliked, and have found it very satisfactory.

Under general measures, we should have in mind the importance of baths, in conjunction with gentle massage and very moderate gymnastics. That the warm bath acts as a sedative and eliminant to an irritable nervous system is conceded, and Hollopeter goes so far as to say that the bath in his hands has been the entire and most satisfactory treatment. He advises a bath at a temperature of 90° to 98°, such as will neither surprise nor shock the child, who is to be immersed in the water all except the head and neck and allowed to remain there for at least an hour or two at a time, twice a day, the last ten minutes being devoted to properly given, gentle, light massage. The prolonged warm bath in one series of fifty cases is said to have shortened the attacks from three months to six weeks.

In the severe cases, attended wtih great muscular weakness, gymnasties will prove harmful, but in the milder forms moderate exercises are permissible, and may have a beneficial effect.

Throughout the active periods of the disease, in some cases, emotionality and perverseness require moral restraint, and so it frequently happens that isolation or hospital treatment is of better avail than the sympathetic interference of meddlesome relatives at the home. The convalescent choreic must not be allowed to prematurely .return to school and studies. Here a long vacation has its distinct advantages.

The medicinal agents called into use in chorea are, broadly speaking, the tonics and sedatives. Of the former, arsenic in one form or another has by common consent been accorded the first place. It has come to be considered the remedy *par excellence,* and as such is another brilliant instance of empiricism in medicine.

Von Bechterew has sought to put the value of arsenic and its action in chorea on a scientific basis. He does not speak of it as a nutrient to nerve tissue, as older writers do, but thinks that it acts on the nerve centers, then on the nerves, the reflexes, and finally on the spasmodically twitching muscles. His premises are doubtful. Now and then we hear enthusiasts or the uninformed referring to Fowler's solution as a specific for chorea, a statement which savors strongly of extravagance and not at all of the truth. The liquor potassi arsenitis is, from an orthodox viewpoint, no doubt, the sovereign remedy in this affection, but in no sense may it be called a specific. Arsenic acts with very good effect on many patients, but its universal administration has shown that a large percentage of choreics remain unbenefited, and I think it neither merits nor enjoys the reputation or popularity accorded it in the past. The toxic effect of arsenic should always be borne in mind, especially in office practice, where it is customary to thoughtlessly prescribe four ounces of Fowler's solution, and fail to caution the patient as to the puffiness of the eyelids, gastric disturbances, paresthesias and weakness in the extremities, which latter two symptoms appear as the forerunners of an arsenical neuritis. This form of toxic paralysis is not to be confounded with the appearance of a disseminated neuritis, which Mills says occurs in certain stages of chorea, just as an arthritis or endocarditis occurs and independent of arsenical treatment.

Spiller has made reference to a number of cases of arsenical neuritis reported, and has himself observed one. Comby has met with such an experience, and Patrick has seen it where large doses of arsenic were given. The original advocates of massive doses of arsenic, Ziemssen and Seguin, and, later, Comby, have found few supporters. To me it seems immaterial whether the neuritis occurs in idiosyncratic individuals or from prolonged large dosage; the point to be remembered is that arsenical neuritis may and does occur, and with the knowledge of such consequence it is incumbent upon everyone administering arsenic to inquire into sensory symptoms and carefully test from time to time the knee-jerks, which, if diminished, should suggest the immediate withdrawal of the arsenic. The ambulatory type of case frequenting the office or the dispensary is not the one from which to draw satisfactory inferences as to treatment. In office practice, whenever administering arsenic, the following precautions should always be observed:

(a) Deny the renewal of the prescription by writing non repetatur. (b) Never let the prescription call for more than four drams of the liquor potassi arsenitis. (c) Give the patient accurate written instructions for graduating the dose, beginning with five drops, and emphasize diluting it with large quantities of water, to a pint, if necessary, to be taken in divided doses. (d) Caution the patient to observe puffiness of the eyelids, nausea, paresthesias and weakness in the extremities. (e) Test the knee-jerks (yourself) at each visit.

It might be well to add that arsenic is generally well borne by the young, and for a child of six or more years to tolerate as much as twenty-five drops of Fowler's solution in a large dilution of water after meals without adverse symptoms is not at all unusual. Thus far preeminence has been given Fowler's solution, but other forms are deserving of mention. Of these I would refer to arsenious acid, which, given in pill form, may contain from 1/100 to 1/30 of a grain. Where great gastric intolerance is present and the chorea steadily progresses, it is indicated, according to Eulenberg and Wiederhofer, to use arsenic subcutaneously. A standardized five per cent. aqueous solution of sodium arsenate may be injected deeply under the skin in ten to twenty minim doses, which latter amount is equal to fifty-two minims of Fowler's solution. The injections, given every second day, have an appreciable good effect in those cases which have hitherto been refractory to Fowler's solution. Even Fowler's solution may be put under the skin in five-drop doses, but some writers discourage all hypodermatic use of arsenic in children.

That chorea has in the past received a fair share of attention from those having remedies to exploit is seen from the very long list of drugs, good, bad and indifferent, cited in the literature, and it is no less amusing to note with what sincerity writers in the past have subscribed to certain of these drugs. As a result of the efforts made to reach special conditions in chorea, such as the insomnia, vesical irritability, etc., the list of remedies is almost interminable, but for purposes of completeness several may be mentioned and a few selected for comment. Belladonna, the hyoscin group, ergot, cannabis indica, exalgin, cimicifuga, strychnia, the iron preparations, the bromides, chloral hydrate, antipyrin, the salicylates—all have been used, though latterly Babinski suggests scopolamine hydrobromate. It is claimed that where chorea has for its basis no other cause than a general lowering of vitality, associated with malnutrition and anemia, strychnia and the iron tonics are of the greatest value. In connection with the rheumatismal types, the salicylic acid group is effective. Among the sedatives, chloral and antipyrin are indicated.

Strychnia as an alterative was first employed by Trousseau and given in the form of the sulphate, with the object of substituting tetanic contractions for the clonic movements. It is agreed by all who use it that the strychnia is best given with large doses of syrup, preferably the syrup iodide of iron, and those who think of this combination say it must be pushed to a point where there is a feeling of tension in the back leg muscles. The iron preparations are too many to enumerate. Suffice to say that iron in an assimilable and palatable form is indicated and well borne.

The esteem in which antipyrin is held by those who have used it freely in chorea is the more astonishing when we reflect upon the misgiving and fear that attends its administration as an antipyretic in the various acute febrile attacks of the adult. Wallner, in 1887, was the first to advocate its use and reported most favorably upon its effect. It is supposed to have a hemolytic action by virtue of which the twitchings are ultimately made to subside. It is then neither as an antiypretic nor analgesic that antiyprin finds its application in chorea, but as a sedative. The tolerance which the young exhibit for antipyrin, given in massive doses and for weeks at a stretch, is well known to those familiar with this remedy. I have myself in a severe case given five grains every two hours in the twenty-four, then reducing the dose to an average of forty grains daily, maintaining that therapy for a week without any show of cyanosis or cardiac depression and with marked improvement to the chorea.

Exalgin, analogous in action to antipyrin and very well thought of by Lowenthal, and Dana, has never been exclusively used. It is claimed that in a dosage of from ½ to 3 grains (for a child under ten), three or four times daily, the drug acts powerfully enough to abbreviate the attack, and is of greatest service in the cases of acute onset. Those who have used exalgin tell of its very marked hemolytic action, producing early anemia with grave symptoms of collapse, and for this reason it seems to me to be open not only to criticism, but serious objection.

In chorea of the rheumatismal type we are confronted with valuable therapeutic suggestions from many reliable sources, all of which point to the employment of the salicylic acid group of remedies.

Lees has vouched for the efficiency of sodium salicylate, and claims that the failure of anti-rheumatic-treatment may be owing to the insufficient dosage. He combines heroic doses of salicylate (100-120 grains daily) with large doses of bicarbonate of soda, and attributes his successes to this combination. These views are not unanimously approved.

Aspirin (aceto-salicylic acid) has its ardent supporters. It is advised to be given without an alkali, as the drug is likely to decompose in the stomach.

Children take aspirin well; it may be given in doses of fifteen grains, three to six times a day, for a child ten to twelve years old, and in ten grain powder for a child of six to eight. Wall thinks it is best given stirred up in cold milk and taken on a full stomach. Occasionally it is rejected, but on the whole it is much better borne than the salicylate of soda, and is not nearly so often attended with the disagreeable symptoms of salicylism, such as deafness, tinnitus, etc. Chloral hydrate, advised twenty-five years ago by Gairdner in England and Bouchut in France, has been employed very little, although its good effect as a sedative is conceded. Opium and the bromides, also much used in the past, have been discarded.

Babinski ascribed his success in the treatment of a case to the use of scopolamine hydrobromate, 2/10 to 5/10 mg. pro die, given under the skin. He remarked upon the quick subsidence of the choreic movements, and added that he had now tried it in four cases with uniform success, and in one of these antipyrin, arsenic and chloral had failed.

Summarizing the therapeusis of chorea, it seems to need revision in favor of the simplest measures.—(D. H.)

Chorea oculi. Choreic (oculomuscular) movements of the eyes and lids due to cerebral disease.

Chorée. (F.) Chorea.

Chorée palpébrale. Choreic movements of the eyelids.

Chorémanie. (F.) Epidemic chorea.

Choreodeitis. (L.) Obsolete form of choroiditis.

Chorio-capillaris. Membrane of Ruysch. A network of capillaries spread over the non-pigmented, inner portion of the choroid. See Vol. II, p. 1388 of this *Encyclopedia.*

Choriocele. A hernial protrusion of the choroid.

Chorio-epithelioma. A name for glioma retinæ.

Chorioid. This spelling is probably more correct than "choroid:" and, since the word is derived from *chorion,* the fetal membrane, and, *eidos,* likeness, both "i's" should, perhaps, be retained. Nevertheless, usage is not to be ignored and it seems probable that these two forms, *choroid* and *chorioid,* as in the case of so many other English words, will both continue to be used by educated people. Which spelling—if either—will eventually be universally adopted is just now a matter of pure speculation. So far as this *Encyclopedia* is concerned both will be employed indifferently in the text, but for headings the shorter (choroid), has been chosen. For *Chorioid* and its derivatives, then, see **Choroid.**

Chorioid. adj. Resembling the chorion; pertaining to the choroid coat of the eye.

Chorioidal. See **Choroidal.**

Chorioïde. (F.) Choroid, choroidal.

Chorioiditis. See **Choroiditis.**

Chorio-rétinite traumatique. (F.) Chorioretinitis due to injury.

Choroid. Also written **chorioid.** The choroid (chorioid) coat or *choroidea* (*chorioidea*) is a dark brown membrane placed between the sclera and the retina. It is thickest at its posterior pole and gradually thins out in front. Consisting almost entirely of blood-vessels its thickness depends upon the quantity of blood present. This accounts for finding it thinner in dead bodies than it is during life. If the vessels are well filled its thickness will be about 0.2 mm. at the posterior pole, while anteriorly it will hardly exceed 0.08 mm. Where the optic nerve pierces the eye coats the *foramen opticum choroideæ* is formed, and here the choroid is firmly attached to the sclera, forming the scleral canal. Anteriorly the choroid runs out in the ciliary bodies without macroscopic limits, and this point corresponds about with the insertion of the external recti muscles. With exception of the *foramen opticum,* where the choroid is firmly adherent to the sclera, the two coats are loosely attached to each other by the lamellæ of the suprachoroidea, as well as by the blood-vessels and nerves which enter the choroid from the sclera. In the macular region this union is somewhat closer.

The *external* aspect of the choroid shows 8 to 10 ciliary nerves running meridionally, and the *arteriæ ciliares posticæ longæ* which accompanied by two nerves traverse the horizontal meridian toward the ciliary body.

The *internal* surface of the choroid is smooth and, if freed from all pigmented epithelium, appears slightly glossy. The network formed by the larger vessels can be seen with the naked eye by transmitted light. This reticulum is dense and irregular about the posterior pole: in the equatorial region four or more groups can be made out where the vessels come together from all sides forming *vortex-like structures.*

The choroid is very elastic and during life is subject to a certain tension. Thus, upon section of the eyeball the choroid will retract slightly from the incision.

Microscopic anatomy. The outer coat forms the *suprachoroidea* which has no proper vessels; it is formed by 6 to 8 layers of very fine lamellæ which occasionally fuse with the *lamina fusca scleræ.* The spaces thus formed are called *perichoroidal spaces.* Connections with the lamina fusca are most numerous in the posterior region of the choroid and are scarce in the anterior portion. In the region of the macula the perichoroidal spaces are completely absent. (Nuel).

Each layer of this coat consists of endothelium, elastic fibers and pigment cells. The endothelium forms a thin *syncytium* (tissue-mass) with large flat nuclei disposed at irregular intervals. The elastic fibers cross each other in all directions, forming a rich net-work. The pigment-cells are branched but the branches are markedly coarse while the cell-bodies show impressions from the crossing elastic fibers. The ciliary nerves form flat bundles within a lamella. One bundle runs along the horizontal meridian having the *arteria ciliaris postica longa* in the middle; next to this on each side is a strand of smooth muscle-fibers and a ciliary nerve on each side.

The *vascular layer* consists of two layers; an outer one which contains the larger vessels, and an inner which holds the finer vessels; there are markedly more veins than arteries. The two layers are separated from each other by an intervascular space lined with endothelium. The veins have a perivascular sheath and *tunicæ adventitiæ* like arteries, but in a reversed proportion to the lumen of the vessel. The vessels are enclosed in a stroma formed by elastic fibers and slender branched pigment-cells which fill the spaces between the vessels while it covers the vessels very thinly. The intervascular spaces, in consequence of this, appear darker than the vessels themselves. If the pigmentation is very marked the ophthalmoscopic picture of a checkerboard fundus appears. Smooth muscle fibers accompany the vessels. The inner surface of the vascular layer is lined with a fine net-work of elastic fibers which does not contain any pigment-cells and which towards the outer layers shows an individual endothelial lining. The finest arteries and veins are found in this layer.

The capillary layer—*chorio-capillaris*—is the most important layer of the choroid; it forms a characteristic feature and marks the limits of this eye coat. It differs from other net-works in its large-sized capillaries, which occasionally form saccular lacunæ. The meshes of this capillary network are narrow and round. Anteriorly the meshes become wider and elongated. The precapillary vessels approach the capillary layer almost vertically about the macular region. At the periphery these fine vessels run a short distance in the capillary layer proper before they enter the capillaries.

The capillaries consist of simple endothelial tubes imbedded in a homogeneous, seldom granular substance which does not show any fixed cells. Smirnow describes elastic fibers in this substance which connect the two elastic networks on either side of the capillary layer. The capillaries are devoid of a perivascular sheath, but instead this layer is covered externally by an endothelial lining which joins the perivascular sheaths of the smallest veins.

The innermost layer of the choroid is the *lamina vitrea* or *elastica,* a membrane not thicker than 2μ, and firmly attached to the chorio-capillaris. Its tendency, when cut, is to curl up toward the outside, it easily forms sharp folds, and tears irregularly. It appears in general structureless, but with very high magnification a delicate pale network, perhaps of fine elastic fibers (Smirnow) can be made out on the surface facing the capillary layer.—(Sattler).

The *lamina vitrea* spilts into two layers of which the outer one has an elastic fiber network, *stratum elasticum supracapillare,* while the inner appears homogeneous even under the highest magnification. The inner surface may show papillary processes in old age (Drüsen) which are to be regarded as cuticular excretions of the pigment-epithelium from which also the entire inner lamella of the *lamina vitrea* most likely takes its origin.

Towards the *foramen opticum* first the vascular layer then the smaller vessels disappear. The capillary layer anastomoses very little with the capillaries of the optic nerve. The passage of larger vessels from the choroid into the papilla (cilioretinal vessels) is to be regarded as an abnormality which nevertheless is not uncommon. Of the various layers, the lamina vitrea approaches nearest the optic nerve, and its free border is not infrequently reflected forwards. The stroma of the choroid goes over into the "Scheidenfortsatz" neurilemma of the optic nerve.

Anteriorly, the capillary layer ends in irregularly widened meshes. The endothelial lining terminates here also, while the other layers extend into the *orbiculus ciliaris.* According to Sattler another narrow capillary network may be found at the border between the choroid and the ciliary body.

The *region of the macula* is characterized by a lack of perichoroidal and intravascular reticulum of fine vessels and capillaries. The *choroidal vessels* form different layers which vary according to the size of the capillaries they contain.

The *arteries* arise mainly from the *posteriores breves,* winding toward the suprachoroidea in which they first run. Then they enter the deeper layers of the choroid, dividing dichotomously. The finest branches are those that form the *choriocapillaris.* Except those vessels which extend a short distance into the *orbiculus ciliaris* no other choroidal vessels enter the ciliary bodies.

The arteries anastomose frequently with one other in the region of the optic nerve; while anteriorly they take a straight course without making connections with each other. Before they end they form a general anastomosis with the *rami recurrentes;* for this reason there are no endarteries.

The *rami recurrentes* are of different sizes, and originate from the *arteriæ ciliares posticæ longæ* and *ciliares anteriores* as well as from the *circulus iridis major.* They supply the most anterior part of the choroid where they break up into fine capillaries.

As far as the vessels of the choroid are concerned, the capillary net of the chorio-capillaris is the densest in the entire body, its meshes measuring 10-20μ around the macula. The small branches enter and leave the chorio-capillaris vertically in the posterior part while anteriorly they take a more oblique course. The veins often originate from a small sinus into which the capillaries flow, converging in a radiating direction. Thus the capillary vortices, the *stellulæ vasculosæ Winslowii* are formed which are especially well developed in animals possessing a tapetum. The veins at first run closely along the chorio-capillaris but with increasing calibre take a more outward course. Only the posterior part of the globe contains large veins in the deeper layers. Here we find numerous venous anastomoses (especially around the optic nerve) into which flow veins from the anterior part of the choroid. All the veins finally end in the vorticose veins, which also form the endpoint for the veins from the iris and ciliary body. As to the course of the vorticose veins outside of the choroid, where they are reduced to a superior and inferior pair, and their mode of distribution within the choroid, the areæ so supplied are commonly divided into two venous regions which correspond to the upper and lower half of the choroid coat. (*Encyklopädie der Augenheilkunde.*) For a further account of this subject see Vol. I, page 388 of this *Encyclopedia,* as well as under the heading, **Histology of the eye.**

Choroid. Adj. Relating to the choroid coat of the eye.

Choroid, Adenoma of. See **Choroid, Tumors of the.**

Choroidal cataract. A synonym of posterior cortical cataract (q. v.).

Choroidal craters. This is a name given to a rare condition described by Griffith and by Ball. It occurs at the macular region and the name "macular hole" is used. It consists of a single area of choroidal atrophy, circular, and sharply-defined by a well-marked ledge. Its depth is about .05 mm., and at the bottom the choroidal vessels are freely exposed. Ball gives concussion injuries as the chief cause. The disturbance to vision varies, though central scotoma is usually present.

Choroidal hemorrhage is not infrequent in various forms of choroiditis, but its presence is rarely determined by the ophthalmoscope. It may be the result of trauma, as contusions of the eye, or intraocular operations. When localized it appears as a dull-red circular or oval area beneath the retinal vessels, and the diagnosis from a deep retinal hemorrhage is almost impossible. Extensive choroidal hemorrhages may produce acute secondary glaucoma. Posey (*Annals of Ophthalmology,* 1909) reported two cases following intraocular operations. One after cataract extraction ending in phthisis bulbi after painful uveitis; the second, after sclerotomy, passed into low grade uveitis with subnormal tension and faint light perception.

Zieminsky (*Postep Okulistyczny,* 1911, No. 8) mentions that Wenzel in 1779 first called attention to the pathogenesis and significance of chorioidal hemorrhages after eye operations. Sattler and Terson have emphasized the fact that for 25 years, *i. e.,* from the time when cataract operations have been performed under cocaine anesthesia, expulsive hemorrhages have become more frequent. Zieminsky describes a case, which was peculiar in that the hemorrhages occurred in a girl, aged 9, after an operation for congenital cataract, without exhibiting a general predisposition or a local cause. The extraction was done under chloroform, followed by vomiting. In changing the dressing next day, the whole contents of the eyeball were found expelled by a profuse choroidal hemorrhage. See, also, **Cataract, Senile**; as well as **Hemorrhage, Choroidal.**

Choroidal crescent. This form of partial atrophy is sometimes seen at the temporal side of the disk. The pigment epithelium may cease some distance from the margin of the opening of the optic nerve.

Over this area the choroid, somewhat rarefied, may be seen and is distinguished from the *scleral crescent* by the fact that it is not pure white, and shows remains of choroidal vessels and pigment.

Choroidal dust. This is a name given to microscopic miliary tubercles of the choroid, which are sometimes so minute as to escape observation unless the fundus is examined with great care. It is in such cases that the ophthalmoscopic illumination of neighboring areas of the ocular background (in the search for fine lesions) with the direct method—after Haab—for the detection of nearby-lesions is indicated and is so useful.

Choroidal fissure is the fetal cleft at the lower part of the secondary ocular vesicle. It admits blood vessels into the interior. Its incomplete closure is described under **Choroid, Coloboma of the.**

Choroidal neoplasms. GROWTHS OF THE CHOROID. See **Choroid, Tumors of the.**

Choroidal pigment. Normally pigment is found in the stroma cells. Abnormal distribution or accumulation is observed in degenerative, inflammatory or mechanical changes in the choroid.

Choroidal retina is that portion which extends from the optic nerve entrance to the *ora serrata.*

Choroidal ring. This surrounds the opening in the choroid pierced by the optic nerve. It is dark-colored, usually incomplete, or shows as a pigmented crescent on one or other side of the papilla.

Choroidal tumors. See **Choroid, Tumors of the.**

Choroidal vein, Aberrant. See **Choroido-vaginal veins.**

Choroidal verrucosities. COLLOID BODIES IN THE CHOROID. See **Choroid, colloid degeneration of the.** Also **Colloid bodies.**

Choroid, Angiocavernoma of the. These tumors are sometimes observed as congenital defects in the choroid. They may occur in any part of the membrane, but are extremely rare. They are congenital and tend to increase in size, resembling in this respect angiomata occurring in other parts of the body. They may be associated with angioma of the neighboring tissues. See **Choroid, Tumors of the.**

Choroid, Angioma of the. See **Choroid, Tumors of the.**

Choroid, Angiosarcoma of the. See **Choroid, Tumors of the.**

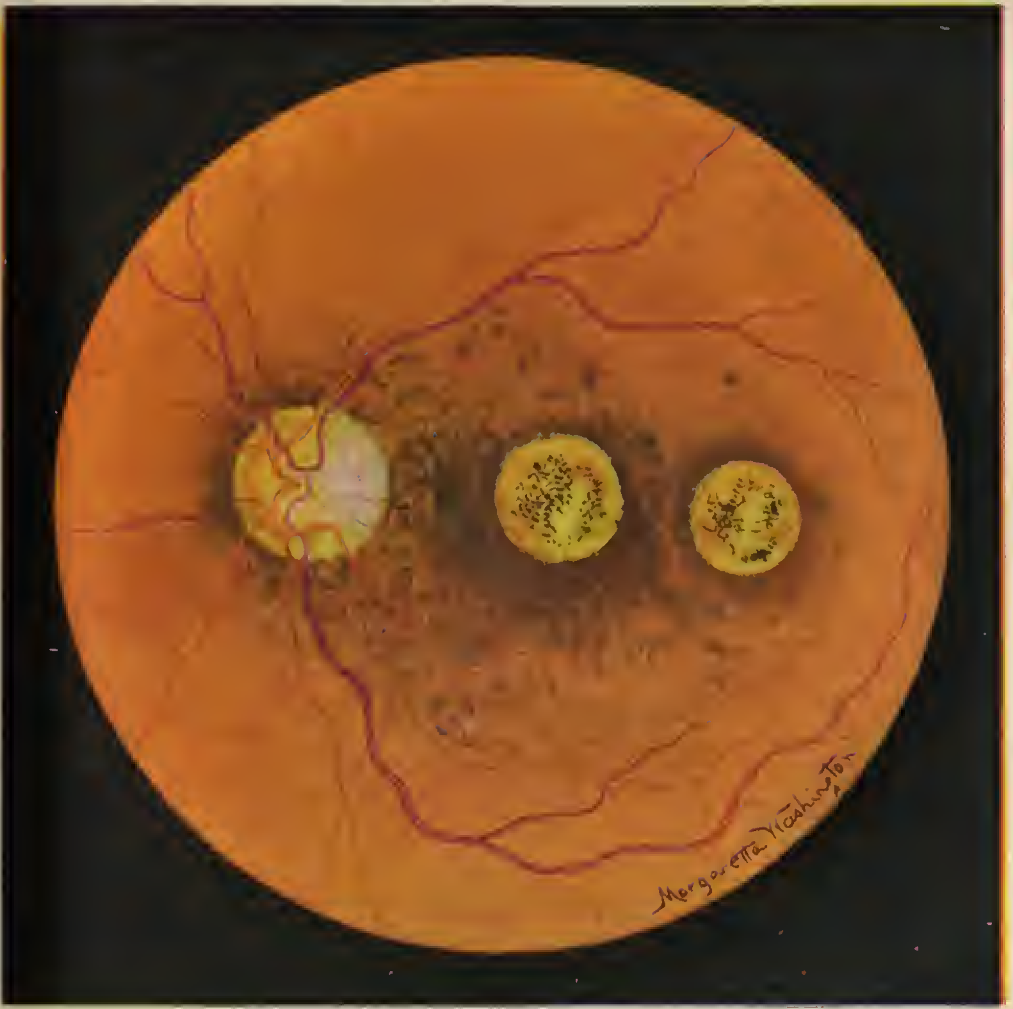
Choroid, Anomalies of the. See **Choroid, Coloboma of the**; also **Congenital anomalies of the eye.**

Choroid, Atrophy of the. This degenerative change is found in the following conditions: (a) after a preceding choroiditis; (b) in vascular changes involving posterior ciliary vessels; (c) from mechanical stretching; (d) in congenital lesions: (e) associated with retinal atrophies from unknown causes. After all forms of subacute and chronic choroiditis and the milder type of the acute form as a rule there is a formation of scar tissue. The degenerative changes the scar undergoes causes partial or complete atrophy of the layers of the choroid as described in *choroiditis in general.* Any obstruction in one or more of the posterior ciliary arteries may cause atrophy of areas varying in size. In old age atrophic changes are common from the arterial degeneration; the macular region is frequently involved and with the atrophy a certain amount of colloid degeneration may be present. In mechanical stretching myopic atrophies have been described under *myopic choroiditis.* Somewhat similar mechanical pressure occurs in glaucoma where, according to Fuchs, the following changes occur: in the choroid the atrophy finds expression in the obliteration of the blood vessels and the rarefaction of the pigment so that the choroid is reduced to a thin, transparent pellicle; this is more pronounced around the papilla giving the glaucomatous halo; the atrophy also reaches a high degree at the spots where the *vasæ vorticosæ* pass from the choroid into the sclera and styphyloma may be present. Atrophies in congenital lesions are seen in the various forms of colobomata and some may result from intrauterine choroiditis. In retinal degenerations a certain amount of atrophy of both retina and choroid may occur as in retinitis pigmentosa, and Fuchs mentions a gyrate atrophy of choroid and retina in rare cases, possibly from consanguinity of parentage.—(E. K. F.)

A most unusual form of choroidal atrophy, yet one illustrating very fully the fundus appearances, is reported by Burton Chance (*Ophthalmic Record*, Jan., 1913, p. 1). In the words of the author the patient did not complain of his sight, yet he was aware that he could not see as well with the left eye as with the right. The visual acuity of the right equaled 6/12, but with the left he could count fingers at three feet only.

Ophthalmoscopically, the right fundus was normal and quite healthy, but the left showed two singularly distinct and marked areas of choroidal atrophy of a character the author could not remember having seen before. At first sight it was almost as though there were three papillæ in the fundus, so sharply circumscribed were the abnormal disks, and so much on a line with the optic nerve head, with which they nearly corresponded in size. The entire fundus showed attenuation of the choroido-retinal sheet and, except within the span of the great vessels in the temporal half, much less pigmentation than in the right eye. In that region there was extensive proliferation of the pigment. The optic disk was large though somewhat atrophic, with a rather broad excavation extending deeply to the lamina which was greenish and stippled.

At about a diameter from the disk was a sharply-outlined, cir-



Unusual Atrophy of the Choroid. (Burton Chance)

cular area of complete choroidal atrophy and at nearly one diameter to the outerside of this area there was another nearly as large and equally as sharp-cut and circular. The smaller area was on a somewhat lower plane than the other, and involved the macula; over the upper border the macular depression shone like the glow above the horizon at early sunrise.

These disks were defined by dark, narrow lines, and on the scleral surfaces there were clumps of uveal pigment arranged somewhat like karyokinetic figures. The choroidal atrophy was complete—the sclera shining with a pearly lustre. There was not a sign of any of the choroidal vessels within either area; nor was the scleral sheet ectatic.

The general arrangement of the intraocular vessels was normal; the large trunks were inclined to be tortuous, and, except for the presence of a fine, elevated fawn-colored spot near the larger disk, there were no other signs of disease observed; nor were there other structural irregularities present. The iris was well formed and manifested all of the normal reactions.

So striking a picture as this the author had not seen before, and it is difficult to explain the origin of the condition. The "disks" cannot be likened to "holes" at the macula, and he can hardly believe that they are the remains of attacks of choroiditis in recent years. Neither is he willing to class them among the colobomata, not because of their unusual position—the inferior section of the fundus was perfectly formed and healthy—for he has known of colobomata occupying the horizontal meridian of the globe. It is true the excessive pigmentation and thickening in the temporal region reminded him of certain other cases he had seen of incomplete colobomata of the choroid in which the deposit of pigment outlined or distinguished the raphé formed by the union of the two edges of the folded layer of the optic vesicle. On the contrary, he regards them to have been produced either as the result of choroiditis in late fetal or very early infantile life. It is not unlikely that the areas were formed by emboli invading the choriocapillaris in these regions.

This case presents one of the vagaries of pathologic processes. It is unusual to find such complete loss of the choroid without there being other signs of inflammation or of degeneration dispersed more or less throughout the fundus. And it is singular that there should have been such pronounced changes of structure in the left eye, while, as far as it could be studied, there were no signs of disease in the right.

Choroid, Bone in the. OSSIFICATION OF THE CHOROID. BONE FORMATION IN THE CHOROID. See **Bone in the choroid.**

Choroid, Calcareous deposits in the. They are sometimes met with in degenerated eyeballs and occur in circumscribed areas. They do not give rise by symptoms and call for no special treatment.

Choroid, Calcification of the. See **Choroid, Colloid degeneration of the.**

Choroid, Carcinoma of the. See **Choroid, Tumors of the**; as well as Vol II, page 1406 of this *Encyclopedia.*

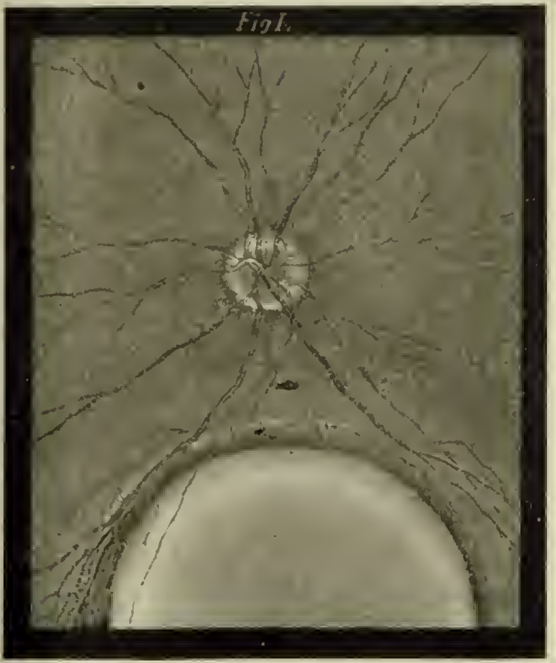
Choroid, Cartilage in the. Pes (*Arch. f. Augenheilk.,* October, 1903) describes a unique case of the formation of a plate of hyaline cartilage in the choroid of a man seventy-eight years of age. It resulted from an injury that occurred thirty-eight years before.

Choroid, Chondro-sarcoma of the. See **Choroid, Tumors of the.**

Choroid coat. The middle coat of the posterior portion of the eyeball; the choroid.

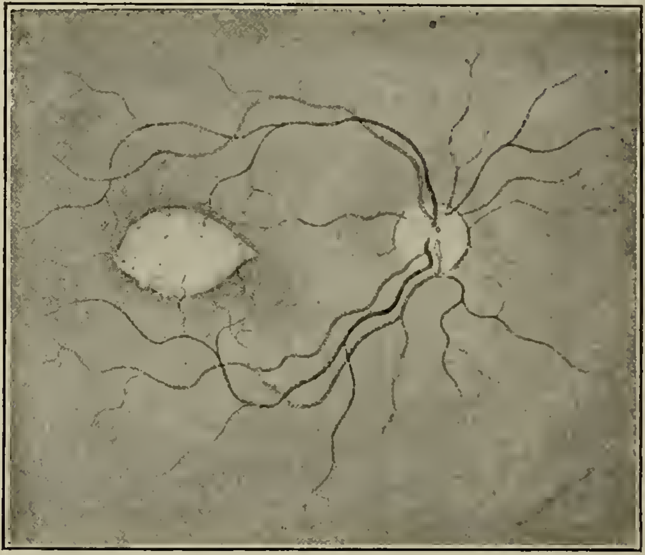
Choroid, Colloid degeneration of the. TAY'S CHOROIDITIS. VERRUCOSITIES OF THE CHOROID. COLLOID BODIES IN THE CHOROID. HYALINE BODIES IN THE CHOROID. Colloid degeneration of the choroid is very frequent in old age. Parsons states it is occasionally found after 30, frequently after 40, and constantly after 60. Colloid bodies are common in shrunken eyes, and may be found in syphilitic lesions; in chronic glaucoma; in cases of retinal pigment degenerations; following trauma; and Alt saw them in a youth of 12. The pathological cause has been the source of much discussion since Donders, in 1855, advanced the theory that they were colloid degeneration of the nuclei of pigment epithelial cells. Leber in an accurate description of them thought they were due to a cuticular substance from pigment cells. Greeff attributed them to change in the cells caused by defective nutrition due to changes in the chorio-capillaries. Coats, in the *Royal London Hospital Reports,* Vol. 16, gave the following theory: The lamina vitrea is made up of two structures, an inner homogeneous layer derived from pigment epithelium, and an outer elastic layer from the choroid proper. The colloid bodies are degenerative changes of this inner or cuticular layer of the lamina vitrea. The colloid bodies may be hyaline or striated and tend to become calcareous. In appearance they are minute, grayish, hemispherical bodies projecting from the inner surface of the lamina vitrea and are from .05 to 1 mm. in size. They may appear as scattered dots over a part of the fundus, as seen in *Tay's choroiditis,* or they may be found in clusters. Griffith states the choroid may be so thickly studded as to resemble a shark's skin. The colloid bodies may become detached from the choroid and may be found in the vitreous. The effect on the vision varies, and depends largely on the degenerative changes in the retina.—(E. K. F.) See **Colloid bodies.**

Choroid, Coloboma of the. This is a congenital defect of the choroid. Two forms are described, "typical" and "atypical." Typical coloboma of the choroid occurs at the lower part and, frequently, a little more to the nasal side. It is usually oval in shape, and may extend to, or include the disk, though as a rule a bridge of choroid intervenes. Coloboma of the iris and other malformations frequently accompany it. Panas states it is more common in the left eye than the right and though generally binocular the left coloboma is larger. Examined with the ophthalmoscope the area appears glistening white with an irregularly pigmented border. Retinal vessels are frequently seen crossing the area and occasionally a few larger ciliary vessels are seen at a deeper layer than the retinal. Pigment may invade the area to a more or less degree. The surface of the area is rarely smooth, but is marked with ridges and indentations. Fuchs, in giving the embryological cause, states the starting point is the fetal ocular cleft. This is found at the lower side of the secondary ocular vesicle and is designed for admission of blood vessels into the interior. This cleft should close completely but the closure may be prevented if the mesoderm that conveys the blood vessels does not undergo retrogression at the proper time. The layers of the ocular vesicles are separated and the interspace filled with mesodermal tissue. From this mesodermal structure fibrous tissue is formed which becomes ectatic from intraocular pressure. Thus the coloboma is primarily in the retina, and is



Coloboma of the Choroid. (de Schweinitz.)

analogous to what occurs normally in certain birds and animals. Collins and Mayou claim in most specimens the microscope shows no gap in the retina. The pigment epithelial layer is absent over a part of the area, though often continued as an unpigmented row of cells before it ceases. The retina can be found in various degrees of attenuation and malnutrition. In some cases light perception may remain in the affected area. Defective vision is the rule in choroidal colobomata. *Atypical coloboma* of the choroid is the name given to congenital defect in other parts of the choroid. Macular coloboma is the more common. Lindsay Johnson gives the name extrapapillary coloboma to the typical case not involving the disk. The coloboma may be from the size of the optic disk to five times that dimension. It is round or oval and similar in appearance to the typical coloboma. It is often associated with other choroidal changes. Many regard the atypical type as the result of intrauterine inflammation. Lindsay Johnson regards some of these colobomata as the atrophied remains of a nevoid growth of the choroid. The choroid receives its blood supply from the numerous short ciliary vessels, and Collins and Mayou advance the theory that the coloboma may be due to a failure in the formation of these blood vessels in the inner part of the mesoblast surrounding the secondary optic vesicle. A rare type is seen where the whole choroid is absent except at the macula. Nettleship in 1908 collected reports of seven such cases, all binocular, with a low degree even of central vision.—(E. K. F.) See, also, **Congenital anomalies of the eye.**



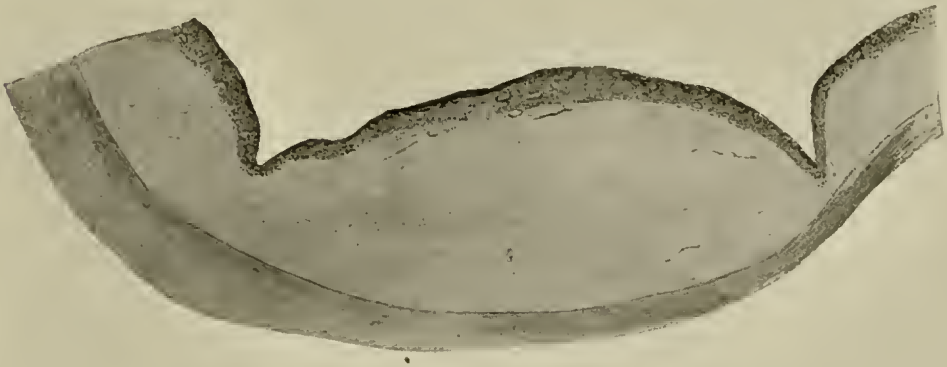
Macular Coloboma. (de Schweinitz.)

Choroid, Congenital abnormalities of the. See **Congenital anomalies of the eye.**

Choroid, Congestion of the. See **Choroid, Hyperemia of the.**

Choroid, Dermoid of the. See **Choroid, Tumors of the.**

Choroid, Detachment of the. Detachment of the choroid is frequently found in shrunken eyes that have been enucleated. The organized exudate in the vitreous exerts traction on the choroid and serum collecting between sclera and choroid may assist in the detachment. It may drag on the ciliary body and cause the shrunken eye to become painful. Clinically, detachment of the choroid is seen after trauma; it may occur spontaneously and Fuchs mentions it following sarcoma of the deep layers of the choroid. Elschnig records a case of detachment at the site of an old choroido-retinitic lesion, possibly from agglutination of retina and choroid, and shrinking of the vitreous. This trauma may be due to injury to the eye from a blunt instrument or may follow intraocular operations. Fuchs (Graefe's *Archiv.,* Vol. 53) reported detachment in 4.4 per cent. after extraction with iridectomy in 318 cases, 5.17 per cent. after simple extraction in 175 cases, and 10 per cent. after iridectomy for glaucoma in 111 cases. J. Meller, also in Graefe's *Archives,* Vol. 80, gives the following classification: post-operative early detachment; post-operative late detachment; and spontaneous detachment. In the causes he gives, first, a diminution of the contents of the globe and a subsequent fall of the intraocular tension; second, a certain degree of rigidity of the sclera; third, a normal degree of adhesion between choroid and retina. He attributes the early detachment to a condition where the fluid, secreted from the ciliary body when the aqueous escapes, does not pass through the epithelium with sufficient activity, and part of it makes its way behind the ciliary body and choroid, detaching both. Fuchs thinks the ligamentum pectinatum is broken in the operation and the detachment is due to aqueous passing behind the ciliary body and choroid. Late detachment may occur from deficient closure of the wound, epi-



Diffuse Detachment of the Choroid. (Greeff.)

thelial inclusions, etc., and others without cause. Spontaneous detachment may occur anteriorly or posteriorly and the cause is obscure.

Symptoms. In early post-operative cases there is shallowness or absence of the anterior chamber, lowered tension and sometimes peripherally dark eminences may be seen. Griffith (Norris and Oliver's *System*) gives the following description: "At some part of the fundus one sees, reaching into the vitreous, and quite immovable, a uniform semi-spherical, slightly-transparent elevation of an orange color, with irregular masses and mossy-like pieces of pigment on its surface, and behind the pigment one makes out a set of vessels, which from their regularity and other character are readily recognized as those belonging to the choroid. There is marked impairment of vision. Diagnosis from detachment of the retina is mainly based on the stability of the choroidal detachment, and the color. The lowered tension assists with the diagnosis from intraocular growths. Prognosis in early detachments after operation is generally favorable. In the later cases reattachment rarely occurs and the eye may become atrophic." Treatment is thorough rest and good elimination.—(E. K. F.)

Choroid, Development of the. The choroid develops from the dense mesodermal tissue surrounding the optic cup and receives its blood vessels from the abundant vascular supply, which even at an early date surrounds the optic cup; and, to a lesser extent, from the retinal vessels.

Choroïde. (F.) Choroid coat.

Choroidea. The choroid coat.

Choroidea propria. (L.) Another name for the *lamina vasculosa* of the choroid, a continuation of the connective tissue web of the *suprachoroidea.* See **Histology of the eye.**

Choroid, Enchondroma of the. See **Choroid, Tumors of the.**

Choroid, Endothelioma of the. See **Choroid, Tumors of the.**

Choroideremia. (L.) Congenital absence of the choroid coat of the eye; or the complete absence of the choroidal epithelium, as in albinism (q. v.).

Choroïde tigrée. The ophthalmoscopic picture of a variety of normal fundus in which the choroidal vessels have the appearance of pale bands separated by spaces of dark color.

Choroid, Flat sarcoma of the. See **Choroid, Tumors of the.**

Choroid gland. This is a structure present in many fishes. It consists of a network of blood-vessels—*rete mirabile*—which has the form of a cushion, lying near the entrance of the optic nerve, between the *argentea* and the pigment epithelium of the retina. Consequently the word "gland" is a misnomer. See, also, **Fishes, Eyes of**; as well as **Comparative anatomy.**

Choroid, Granuloma of the. See **Choroid, Tumors of the.**

Choroid, Growths of the. Choroidal neoplasms. See **Choroid, Tumors of the.**

Choroid, Gyrate atrophy of the. Weeks (*Text Book*, p. 464) says that Fuchs (*Arch. of Ophth.*, 27, No. 5, p. 480) describes a peculiar form of choroidal and subsequent retinal atrophy, of which he has observed a few cases. The disease is characterized by the development of a broad zone of atrophy, apparently corresponding to the capillaries terminating the short ciliary arteries. The affection begins by the appearance of circular atrophic spots in the choroid which slowly extend, coalesce, and eventually form an atrophic zone with irregular margins, encircling macula and disk. During the development of the affection, which progresses extremely slow, the atrophic spots may assume various shapes and bands of more or less normal choroidal and retinal tissue may extend between them. Both eyes are affected symmetrically. In one case reported by Fuchs the patient was night-blind from early childhood. The retinal vessels and disk had the same appearance as in typical retinitis pigmentosa, and there was present the stellate opacity —posterior cortical cataract—which is so often met with in the last-mentioned disease. The vision was greatly reduced, corresponding to the changes in the fundus.

Choroid, Hyaline bodies in the. See **Choroid, Colloid degeneration of the.**

Choroid, Hyaline degeneration of the. See **Choroid, Colloid degeneration of the.**

Choroid, Hyperemia of the. Hyperemia of the choroid cannot be diagnosed with certainty with the ophthalmoscope. The condition is deduced from the hyperemic condition of the papilla, and alteration in the color of the retina. Refractive errors, and exposure to bright light are given amongst the possible causes. Treatment is rest to the eyes, protection from bright light and mild elimination, and any refractive errors should be corrected.

Choroidido-cyclitis. Plastic or purulent inflammation of the choroid and ciliary body: the usual condition observed in sympathetic ophthalmia.

Choroid, Inflammation of the. See **Choroiditis in general.**

Choroid, Interfascicular epithelioma of the. See **Choroid, Tumors of the.**

Choroidiritis. Choroido-iritis.

Choroïdite. (F.) Choroiditis.

Choroïdite aréolaire. (F.) Areolar choroiditis.

Choroiditis, Acute. The expression usually refers to suppurative choroiditis; sometimes it is applied to the inflammatory stage of the exudative variety.

Choroiditis æquatoralis. This expression is used by Magnus to indicate rare forms of disseminated choroiditis, where the infiltrated areas appear only at the equator. It sometimes forms a ring, when it is called annular choroiditis.

Choroiditis albuminurica. ALBUMINURIC CHOROIDO-RETINITIS. In nearly all cases of albuminuric retinitis the choroid is also involved, though this lesion is not always revealed by the ophthalmoscope on account of edema of and opacities in the retina. Some cases show marked pigmentary disturbance and dark pigmented areas may be found near retinal degenerative plaques, giving the appearance of areolar or disseminated choroiditis; or it sometimes simulates retinitis pigmentosa.

Choroiditis, Ametropic. Gould describes cases of macular choroiditis said by him to be due to uncorrected ametropia.

Choroiditis annularis. See **Choroiditis æquatoralis.**

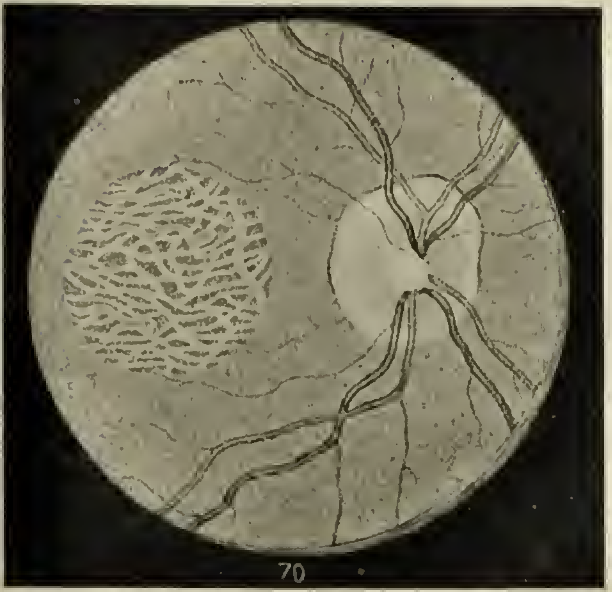
Choroiditis, Anterior. The foci of exudation in this disease are at the periphery of the choroid and it requires a dilated pupil before they can be seen. Degenerative changes in this variety are common in excessive myopia, and the accompanying pigmentary changes occur frequently in old age. In young persons anterior choroiditis occurs in inherited syphilis and it may be associated with interstitial keratitis and iritis.

Choroiditis, Anterior sclerotic, is a condition where atrophy of the choroid occurs anterior to the equator of the eye. It is accompanied by bulging of the sclera in that region.

Choroiditis, Areolar. CHOROIDITIS OF FÖRSTER. This is a limited form of disseminated choroiditis, although regarded by some as a degenerative change rather than an inflammatory one. It is nearly always binocular and the changes are confined to the disk and macula. In early stages the areas are black and become decolorized from the centre outwards, until they appear as excavated patches of atrophy. The vision may remain good or may suddenly fail without further ophthalmoscopic changes. See, also, **Areolar choroiditis.**

Choroiditis, Capillary. See **Choroiditis, Superficial.**

Choroiditis, Central, is a condition in which the macular region is involved. It may occur as a limited form of disseminated choroiditis, as a senile change, or in young without special cause. It is very common in old people especially after sixty years of age, and it is bilateral. It may develop after an injury, such as a blow on the eye. Changes in high myopia occur in the macula mainly where of an atrophic nature and central scotoma is present. The *treatment* depends on the etiology.



Central Choroiditis. (After de Wecker and Jaeger.)

Choroiditis, Chronic. Same as **Choroiditis exudativa.**

Choroiditis, Circumscribed, is that condition in which areas of exudative choroiditis are localized. Hepburn classifies all forms of exudative choroiditis according to the degree of vascularity, and points out that the areas may be superficial or deep, depending on the arterial blood supply.

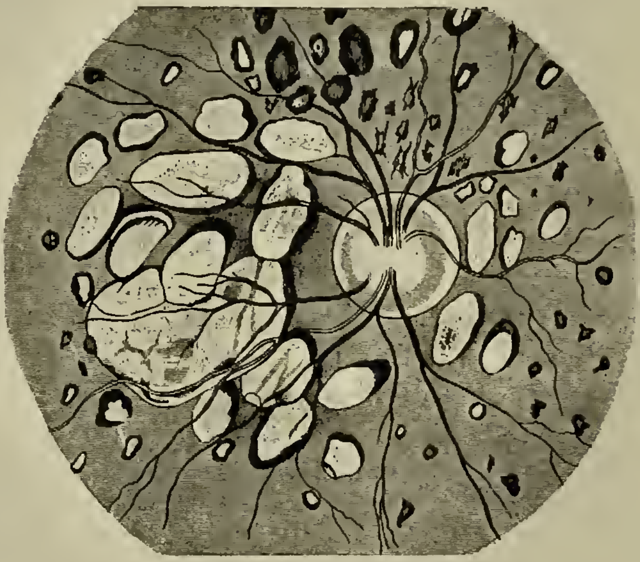
Choroiditis, Deep. A term applied to all forms of exudative choroiditis.

Choroiditis, Descemititic. Hill Griffith has described a few cases in exudative choroiditis where dust-like opacities appeared on Descemet's membrane; the iris was normal but there were opacities in the vitreous.

Choroiditis, Diffuse. This is a form of exudative choroiditis involving a large part of the choroid. Hepburn uses the term to specify a choroiditis due to general disease of the vascular walls, leading to exudation of albuminous fluid into the stroma of the choroid. The lesion gives rise to a general edematous haze, subsequent fibrous tissue develops and imparts a uniform grayish appearance to the affected fundus. Constriction of the blood vessels and pigmentary degeneration of the retina occur. Weeks describes the disease as chiefly involving the capillary layer, with fine exudates into the vitreous. It occurs in children and young adults and is due to inherited syphilis.

Choroiditis disseminata. Specific choroiditis. Disseminated choroiditis is the most common form of exudative choroiditis and is the name given to those forms where the infiltrated areas and atrophic patches are spread over a large part of the fundus. The etiology is practically the same as that of non-suppurative choroiditis. Syphilis, either acquired or inherited, is the chief cause, though Axenfeld, von Hippel, and others regard tuberculosis as an important factor in the etiology. Weeks also mentions any profound disturbance of nutrition, as in anemia and malaria, and cites Meiers' report of 238 cases where syphilis and tuberculosis were rare; chlorosis in the females was usually present; scarlatina and rheumatism seemed to be causes. Stock obtained a disseminated choroiditis of a metastatic nature in rabbits by the intravenous injections of culture of the bacillus pyocyaneus.

Disseminated choroiditis may be confined to one eye or both may be affected in different degrees. Parsons (*Pathology of the Eye*, Vol. 11, Page 458) gives the following description of the pathological changes: There is at first a circumscribed, perivascular infiltration in the innermost layers of the choroid while the outer layers remain normal. The infiltration increases, causing slight swelling; this stage corresponds with the yellow spots seen with the ophthalmoscope. The *lamina vitrea* may remain intact but exudation collects in small quantity between the retina and the choroid. The pigment epithelium undergoes degenerative changes. The infiltrated area becomes organized, the vessels being destroyed by the process; the retina invariably becomes degenerated over this spot and is knit together with the choroid by means of fibrous tissue. The retina and choroid are thinned and atrophic in the affected area, and pigment disappears from the centre and collects at the edges where it is often very dense.



Ordinary Form of Disseminated Choroiditis.

Symptoms. Disseminated choroiditis generally begins in the periphery and gradually extends over the fundus. Many cases in the early stage present no subjective symptoms, and are not seen until the disease is well advanced. At first, the exudates appear as yellowish or greenish-gray discolorations beneath the retinal vessels, which may be raised slightly over them. In rare cases these exudates are absorbed, but as a rule they go on to atrophic changes when the characteristic picture of disseminated choroiditis appears. The ophthalmoscope shows a large number of circular or oval white areas, many the size of the disk, with pigmented borders. Between these areas the choroid is comparatively healthy. Vitreous opacities are frequent. On account of changes in the retinal pigment there may be some small, black masses circled with yellowish rings. In old cases the retinal pigment may be absorbed and the choroidal vessels exposed. In advanced cases the optic nerve may become atrophied, and liquefaction of the vitreous and opacities in the lens may occur. The disturbance of vision depends largely on the condition of the macula, but there are always alterations in the field of vision, and night-blindness is frequently present. The prognosis is unfavorable as permanent changes in choroid and retina occur. *Treatment* depends on the cause and has been discussed under **Choroiditis in general.**—(E. K. F.)

Choroiditis, Doyne's. This is the name given that form of familial choroiditis in which the deposits appear with the ophthalmoscope to be clustered together like a "honeycomb." See **Choroiditis, Familial.**

Choroiditis, Embolic. See **Choroiditis in general.**

Choroiditis, Epithelial. See **Choroiditis, Superficial.**

Choroiditis ex ictero. CHOROIDITIS FROM JAUNDICE. Same as **Choroiditis hepatica.**

Choroiditis exudativa. See **Choroiditis in general.**

Choroiditis, Familial. DOYNE'S CHOROIDITIS. FAMILY CHOROIDITIS. HEREDITARY CHOROIDITIS. This is a rare form occurring in families. De Schweinitz describes it as disseminated choroiditis encountered as a family disease independently of syphilis, and gives Hutchinson as the authority that it is associated with disorders of the central nervous system. Doyne (*Trans. Oph. Soc. of United Kingdom,* 1910) reported a number of cases and described it as "honeycomb" choroiditis. The area affected is the neighborhood of the disk or the macula; and the exudates resemble those of *guttate choroiditis.* The spots are closely grouped, and are sometimes separated by pigment but more often by none. The condition appears in early adult life, or later, but the vision is not affected until late in life. Treacher Collins (*Ophthalmoscope,* Sept., 1913) in the microscopical examination of a case, showed that the lesion is due to hyaline degeneration similar to that described under colloid degeneration of the choroid. Lutz (*Annal. de Oftalm.,* Mexico, Aug., 1912) has described a choroido-retinal disease occurring in four sisters of a family of nine, with negative family history. Both eyes were affected and the disease appeared between the tenth and twelfth years, with marked diminution of vision and with pigmentary changes in the posterior pole of the eye.—(E. K. F.)

Choroiditis, Förster's. See **Choroiditis, Areolar.**

Choroiditis from leprosy. CHOROIDITIS LEPRÆ. In leprosy the choroid is affected secondarily to the ciliary body. Clumps of lepra bacilli may be found in the capillaries, associated with edema and infiltration.

Choroiditis, Guttate. A variety of disease of the choroid was described in 1875 by Tay and Hutchinson. It is sometimes called *Tay's choroiditis,* and is a senile degeneration. Small whitish dots are seen by the mirror around the macula. They may be clustered together; and frequently the vision is impaired but slightly, if at all. These dots are really *colloid excrescences on the lamina vitrea,* are due to degeneration of the pigment epithelium and generally occur in both eyes. They tend to increase and do not respond to treatment. See **Colloid bodies.**

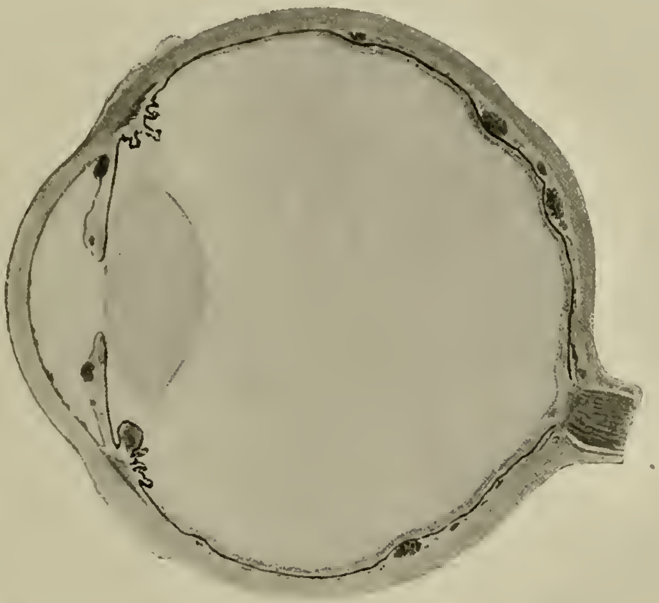
Choroiditis hepatica. This is a chronic, exudative choroiditis said to occur in certain disorders of the liver.

Choroiditis, Hereditary. See **Choroiditis, Familial.**

Choroiditis, Honeycomb. DOYNE'S CHOROIDITIS. See **Choroiditis, Familial.**

Choroiditis hyperplastica. In rare cases of exudative choroiditis the granulation tissue is very extensive and may involve both retina and vitreous. Schöbl gives this condition the name *choroidoretinitis hyperplastica traumatica* and describes cases following a penetrating wound with a foreign body lodged in the posterior chamber. The changes are most marked in the retina and vitreous.

Choroiditis in general. Inflammation of the choroid is not attended by any external manifestations of its presence. The disturbance of vision which is always present in a more or less marked degree is due to retinal involvement. The ophthalmoscope alone reveals most of the changes the eye undergoes. It is a fairly common affection occurring at all ages and on account of danger to the retina, permanent impairment of vision is always a grave possibility. Choroiditis is either *suppurative* or *non-suppurative* and the two varieties differ so radically as to require separate description. *Suppurative choroiditis* is usually a part of panophthalmitis and the most common cause is a perforating wound with septic instruments. Thus it may follow intraocular operations, or a penetrating foreign body may produce it. It may result from an extension of inflammation from other parts of the eye, as from corneal ulcers, and Hodges mentions it as extending from Tenon's capsule along the perforating vessels. Less commonly it is due to endogenous infection, and this will be discussed under a subdivision of the subject as metastatic choroiditis. Suppurative choroiditis rapidly extends to other structures until the entire eye is involved. Febrile disturbances occur, frequently nausea and vomiting, while the pain over the eye is intense. The eye-lids are swollen and the conjunctiva is chemotic. The cornea becomes so hazy it is difficult to see the underlying structures. The aqueous is turbid and often contains pus, and marked signs of iritis are present. The eyeball is protruded and its movements limited, and when perforation occurs the pus escapes near the equator. The pathological changes begin in the inner layers of the choroid around the capillaries and smaller vessels. An extensive infiltrate occurs, breaks through the lamina vitrea and pours into the vitreous. Both veins and arteries are occluded and frequently undergo necrotic changes with hemorrhages more or less extensive. The choroid is thickened and frequently separated from the sclera, while extensive detachment of the retina may occur. Many of the suppurative processes begin in the retina and extend to the choroid. The prognosis for the eye is always bad as the sight is invariably destroyed. When perforation occurs, phthisis bulbi results, and is as a rule harmless. Fortunately the suppurative process seems a safeguard against sympathetic ophthalmia. There is always danger of extension of the suppurative process and of pyemia resulting. When perforation does not occur, the exudate may be organized and shrink, with atrophy of the bulb which may be painful and a source of danger to the other eye. In the early stages very little can be done except good elimination and hot applications. Woodruff reports beneficial results from deep subcon-



Metastatic Choroiditis. Early Stage. (Axenfeld.)

junctival injections of mercury oxycyanide. Aspirin and even hypodermic injections of morphine may be necessary for relief of pain. When suppuration takes place the eye should be incised or eviscerated; enucleation is dangerous especially if surrounding tissues are involved as septic meningitis has followed this operation.

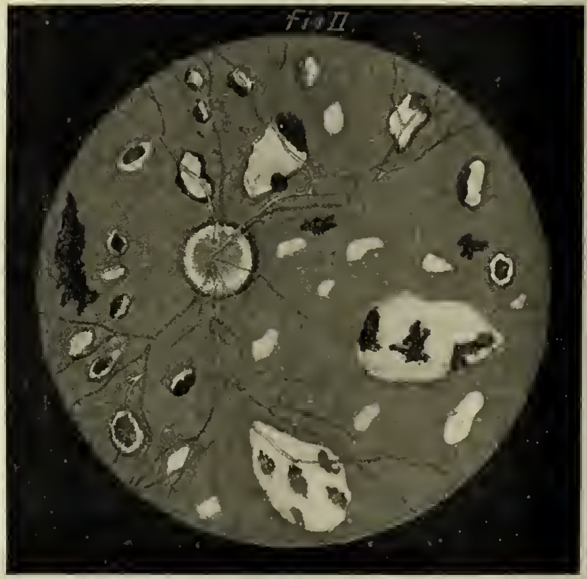
Metastatic choroiditis is the name given to the cases arising from endogenous infection. Weeks terms it *embolic choroiditis* and subdivides it into the suppurative and plastic types. Parsons uses the term "metastatic suppurative choroiditis" only for such cases as occur in puerperal fever and other cases of surgical pyemia where septic emboli are carried to the choroid. Milder cases ending in pseudoglioma he classifies under exudative choroiditis, as suppuration does not occur and they are the result of toxins rather than micro-organisms direct. The names endogenous panophthalmitis and septic endophthalmitis are also used to distinguish the more virulent types. Fuchs mentions metastatic choroiditis as following vaccination, typhoid fever, variola, scarlet fever, anthrax, influenza, ulcerative endocarditis, diphtheria, pneumonia.

Wilder has reported three cases: one from general sepsis where staphylococcus aureus was found in the blood, one from streptococcus infection starting as a tonsillitis, and the third had diphtheria and streptococci infection of the throat. In cerebral meningitis there may be an extension of the morbid process along the lymph spaces of the optic nerve. In puerperal fever it occurs from 6 to 14 days after confinement, and generally ends in perforation. In 63 cases Axenfeld found only 22 were bilateral. The suppurative cases rapidly end in panophthalmitis and the organisms found are streptococci, staphylococci or pneumococci. Fatal terminations from pyemia are not infrequent. In the milder types there is an extensive infiltrate into the vitreous, which in rare cases has been absorbed but as a rule becomes organized. This exudate often resembles a tumor, hence the term pseudoglioma. This is distinguished from a glioma by its dirty-yellowish color. There is always evidence of a previous inflammatory condition as iritic adhesions, and retraction of the periphery of the iris, and the tension of the eye is diminished. The vision is nearly always destroyed, and atrophy of the eye is the frequent result. Symptoms of metastatic choroiditis depend on the character and virulency of the infection. The retina frequently is involved first but soon there is an inflammation of the whole uveal tract. This may be of a plastic nature and attended with little pain, though with marked disturbance of the vision. In other cases the pain may be intense and all the symptoms of suppurative choroiditis may be present. In milder cases after the acute attack is over the yellowish exudate can be seen behind the lens. Treatment in the suppurative cases is the same as in panophthalmitis. In the milder cases atropine and hot applications are used with leeches to the temple. Subconjunctival injections of normal salt solution or mercury oxycyanide may prove beneficial. Constitutionally mercurial inunctions with iodides internally or large doses of sodium salicylate afford the best results.

Choroiditis non-suppurativa (choroiditis exudativa) is subacute or chronic in its course and shows a variety of forms and symptoms. The more common types as disseminated, circumscribed, plastic, etc., belong to this classification. It is a frequent disease and found in all ages and conditions. In searching for the cause of choroiditis the following points should be borne in mind: The choroid is an extremely vascular structure with plexuses of greater density than in any other part of the body; also the blood supply is received from a large number of arteries, and but few veins remove it. This tends to a slow circulation which therefore predisposes to a chronic or subacute inflammation. Thus choroiditis may result from any circulatory disturbance, as in arterial changes, or alteration in the quality of the blood supplied. Syphilis, both inherited and acquired, is a frequent cause. In tuberculosis it may result from the general malnutrition or localized foci may occur in the choroid. It occurs in general disorders of nutrition as in anemia and chlorosis. Lawford mentions also autoinfection—certain systemic diseases as malaria, gout and several of the exanthems; certain occupations such as workers in naphthalin; diseases of liver and kidneys. To this may be added traumatism, exposure to intense light, heredity and eye-strain from uncorrected ametropia. Meyer states it is sometimes found in women with menstrual disturbance or at the climacteric. Davis reported three cases due to pyorrhea alveolaris, the exciting organism being staphylococcus pyogenes albus, with marked improvement after attention to the teeth, and one case due to a chronically diseased appendix. In many cases the etiologic factor is difficult to determine. Many of the choroidal changes described as choroiditis are only atrophies of a mechanical nature rather than inflammatory conditions, as seen in myopia.

The pathological changes consist of a cellular infiltration from the capillaries and smaller vessels, with more or less localized dilatation of the larger vessels. The exudate may be localized or diffused and varies greatly in quantity. Slight elevation of the retina over infiltrated areas occur and there may be detachment of the retina. Absorption of the exudate may occur but it more frequently filters through the lamina vitrea into the retina and vitreous. The pigment cells of the retina proliferate and free pigment migrates into the choroidal and retinal structures. Granulation tissue is soon formed which is transformed into dense fibrous tissue. The normal blood vessels in the area are destroyed, until few or no blood vessels can be seen in the scar, though a few larger vessels may survive as broad bands. A permanent scar may remain surrounded by and infiltrated with pigment cells, or it undergoes degenerative changes and localized atrophic areas of both retina and choroid may occur with the white sclera exposed.

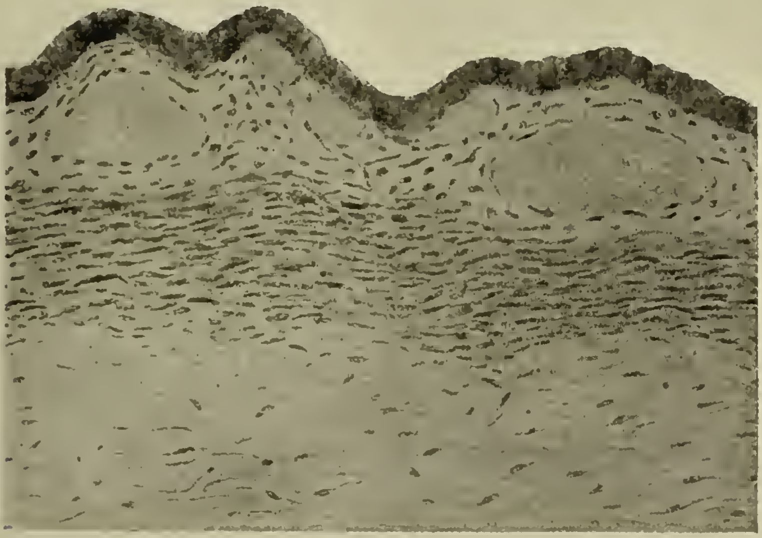
Symptoms of exudative choroiditis depend on locality and amount of exudate and retinal disturbance. Distorsion of images, lowered vision and flashes of light are common. If the areas of inflammation do not involve the macular region the patient may be unaware of any disturbance, but scotomata can be demonstrated on taking the field of vision. Vitreous opacities of varying degrees of density are frequent which may become absorbed or remain permanent. In the early stage, or stage of infiltration, the ophthalmoscope shows isolated foci of inflammation scattered over the choroid. They appear as grayish areas with blurred outlines beneath the retinal vessels. Later in the cicatricial stage the areas are paler with pronounced pigmented borders. The choroidal vessels may be obliterated or appear as bands in the scar. In the atrophic condition the white sclera is seen and the area irregularly pigmented. Fuchs gives the following distinction between recent exudates and old atrophic spots on the choroid: Exudates are of a yellow or yellowish-white color, do not have a sharp outline, and present no choroidal vessels; retinal vessels which by chance run over them show by their bending that a projection of the retina



Exudative Choroiditis. Late Stage. (de Schweinitz.)

exists here due to the prominence formed by the exudate. The atrophic spots are pure white and have an irregular but sharp outline often formed by a pigmented band. Pigment spots also lie in the white spot itself; sometimes the growth of pigment becomes so excessive that the spots finally become entirely black. Moreover, remains of the choroidal vessels are visible within the atrophic area. Such vessels not infrequently present thickened, white-looking walls, or are even quite obliterated and converted into light-colored chords.

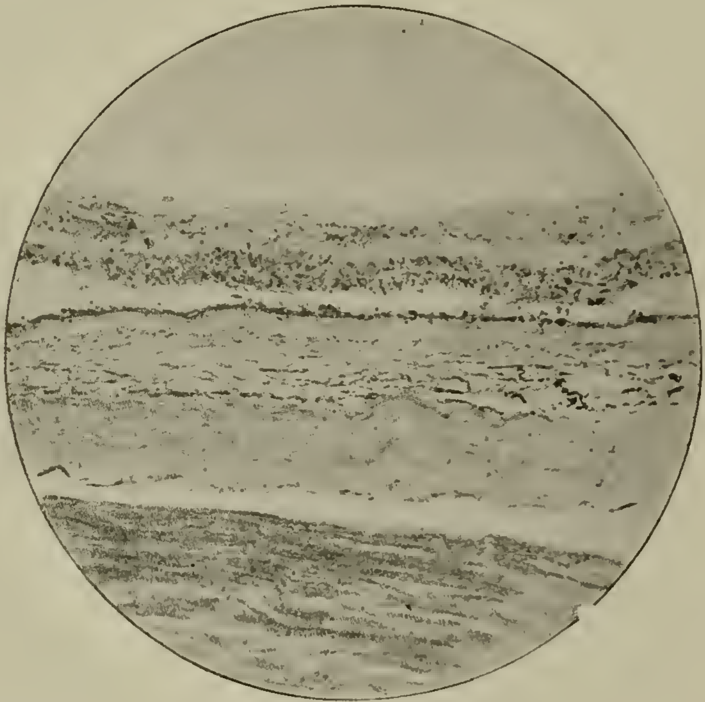
Inflammation or other lesions of the choroid may affect mostly or alone the tissues of the suprachoroidea. Such a condition is sometimes referred to as *suprachoroiditis.* Parsons (*Pathology of the Eye,* Vol. 2, p. 453) says that fibrous tissue may replace the suprachoroidea by dense scar tissue, just as the choroid may be attacked by inflammation from the outer side, by way of the suprachoroidal space. This, he says, is due to filtration of toxins, etc., from the ciliary body into the space, where they may cause localised foci, or may become diffused and lead to general choroiditis. "The suprachoroidal space then at first contains exudates, which correspond in situation with foci of inflammation in the overlying uvea; the space outside the flat part of the ciliary body is usually first affected. In the milder attacks of exogenous and endogenous inflammation these exudates organise. The same condition may ensue from subchoroidal hemorrhage (Bloom). It is by no means an uncommon feature in shrinking or shrunken eyes. The chromatophores of the suprachoroidea undergo the usual inflammatory changes; they lose their processes and become rounded, the pigment being aggregated into large dense clumps. The leucocytes



Suprachoroiditis.

Obliteration of the suprachoroidal space. (Greeff.)

and blood-corpuscles gradually disappear. The chief changes are seen in the endothelial cells. These normally show only large pale nuclei, crossed by elastic fibres of the suprachoroidea. They now show a definite cell body with processes (Fuchs). These form a network, or run parallel to each other, the intercellular substance showing fine fibrillæ. In van Gieson's specimens the new tissue is red and clearly distinguished from the original suprachoroidal stroma. The fibrillæ increase in numbers, and are orientated like the original planes of the suprachoroidal laminæ, being subjected to similar stress and strain. The fibrillæ develop into thicker fibres, and the nuclei become longer, narrower, and more deeply stained. The new fibrous tissue is especially noticeable around the blood-vessels, showing the important part played by the adventitia in its production. The fibres often form a thick network with few nuclei; in other places they run parallel, following the direction of the choroid and sclera. The suprachoroidal lamellæ are gradually replaced by this thick tissue, but are long recognisable as strands of pigment cells. The thickened suprachoroidal tissue is traversed by new-formed vessels, which greatly vary in number. Their development from simple endothelial tubules to fully-formed vessels, sometimes going on to hyaline degeneration, can be well traced. Most are derived from the anterior and posterior ciliary arteries, but some grow direct from the scleral vessels. The new tissue often contains



Suprachoroiditis. (Parsons.)

From an eye with traumatic iridocylitis. There is a thick layer on the outer side of the choroid, possibly due to organization of blood-clot.

spaces of various sizes, due to collections of fluid exudate. As the droplets increase in size the pigment and endothelial cells are pushed aside, so that large, round, or elliptical spaces are formed. The larger the spaces, the more densely is the fibrous tissue pressed together, and the wall is further thickened by proliferation. The thickening is generally seen first at the posterior end of the larger spaces, filling in the triangular space between the detached choroid and the sclera; later it becomes evident at the anterior end, and finally a dense capsule is completely formed. The inner snrface of the capsule is smooth, and often has a sort of endothelial lining, as shown by the flattended nuclei. The thickest suprachoroidal membranes are found after hemorrhage, but there is good evidence that they also occur with simple serous exudation. They become denser, less nucleated, and poorer in blood-vessels as they grow older. They are particularly free from vessels when they are adherent to the sclerotic, whilst those adherent to the choroid may be extremely vascular. Often the membrane is fused neither with the choroid nor the sclerotic, but is separated from both by layers of spongy lamellæ; this corresponds with the distribution of the exudate in many early cases of inflammation. The choroid may be thrown into large folds by the contraction of the organising tissue. The membranes adherent to the sclera are commoner than the other types; the limitation from the sclera is always well marked, since the tissue is always richer in nuclei, and is more finely fibrillated. The masses of fibrous tissue may be several millimetres thick, so that it is not surprising that such a case has been described as a fibroma of the choroid (Schiess). They apparently never, in their later stages, undergo ossification (Fuchs), therein differing in a striking manner from the similar deposits on the inner surface of the choroid. The inflammatory process is accompanied by increased secretion from the choroid. This is at first slight, and in many types of sub-acute choroiditis remains so permanently. It is then limited to an edematous condition, with some accumulation of fluid in the subchoroidal spaces. The secretion rapidly becomes pathological as regards its constituents, containing, like all inflammatory secretions, an excess of proteids, which are allowed to filter through the injured vessel walls. The pathological exudate, like its normal progenitor, filters through the membrane of Bruch into the retina, and even through this into the vitreous. The cellular—leucocytic—and probably the precipitated albuminous constituents thus give rise to the dusty or more concrete opacities in the vitreous which are familiar in the ophthalmoscopic picture. In the more severe cases the ciliary body undoubtedly participates in the inflammation, especially in anterior choroiditis, and it is improbable that the grosser opacities can be formed without such participation. We are more cognisant of the liability of the ciliary body to participate with the iris in inflammatory processes, because here they are more readily observed. The uveal tract, however, in many diseases suffers as a whole, as might be expected on anatomical and physiological grounds. It is more than probable that the part played by the ciliary body in many forms of choroiditis has hitherto been under-estimated."

The *prognosis* in most forms of choroiditis is grave because complete absorption of the deposit or repair of the lesions is rare.

The disturbance to vision depends on size and locality of the areas of infiltration. Extensive choroiditis of long standing ends in degenerative changes of retina, disorganization of the vitreous and the lens may become cataractous. *Treatment* depends on the etiologic factor and a thorough systemic examination should be made in each case. Any source of autoinfection must receive attention. Good elimination should be enforced. If syphilis is present a thorough course of mercury, preferably by inunctions, followed by iodide of potassium in large doses, affords good results. Salvarsan has not appeared to be of much benefit in these cases. Even in nonsyphilitic cases iodides and diaphoresis aid in elimination. Tuberculous cases have been improved by the use of tuberculin. Locally, the eye should be protected from bright light, and given as much rest as possible. If not contraindicated atropine may be used, and beneficial results have been reported from subconjunctival injections of normal saline solution.—(E. K. F.)

So far as the *treatment of hyperemia of the choroid* is concerned, the removal of the cause of the choroidal engorgement, the correction of refractive and muscular errors and the prescription of ocular rest form the chief part of successful treatment. Most of these indications are met by atropia, the wearing of tinted lenses and the application of dry heat to the ocular region three or four times daily.

In the *treatment of the simple or non-suppurative forms of choroiditis* the cause of the disease is often discernible by the ophthalmoscope; indeed a study of the fundus changes is probably the most valuable means we possess of properly directing treatment. In *choroiditis disseminata*, for example, we have a picture almost pathognomonic of syphilis. In luetic lesions the treatment is generally very successful if it is applied before the tissue destruction, especially of the overlying retinal elements, is too great. It is in these forms of choroiditis that subdermal or intravenous injections of mercurial preparations, inunctions, large doses of iodides, alone or in conjunction with pilocarpine sweats, Turkish or cabinet baths, will be found very efficacious.

In nearly all the acute cases the eyes should be put at rest with atropia, colored glasses should be worn and the patient should avoid brightly lighted rooms or direct sunlight. In addition to the general treatment proper to each case, leeching or dionin (or both remedies) is of some value. That a *concomitant iritis,* iridocyclitis or hyalitis should receive attention goes without saying. In the chronic forms of choroiditis I believe that subconjunctival injections of normal saline solution, followed by or alternating with the employment of potassium iodide or iodate, are sometimes efficacious, particularly in clearing the vitreous opacities that often prove to be the most serious sequelæ of the disease.

Gifford's plan of prescribing sodic salicylate should also be borne in mind, especially in the simpler or non-luetic forms of exudative choroiditis.

It must be pointed out that a definite distinction should be made between atrophic areas and old deposits in the choroid and fresh, recent lesions. The latter furnish some hope of repair; the former are the scars of a partially healed or wholly healed process and any endeavor to cure them is to attempt the impossible. Again, we find that a correct diagnosis is essential to rational treatment.

So far as the *treatment and general conduct of suppurative or infective choroiditis* is concerned not very much can really be done. As even the mildest forms of the disease (circumscribed suppurative choroiditis, for example), are fraught with gravest consequences to vision and generally progress until the eye is destroyed, it is important to use the most effective prophylactic measures we possess when danger threatens, as well as to begin treatment at the earliest stage of the infection.

In threatened infection of the intraocular contents from exogenous sources the path of infection should be disinfected at once with iodoform rods, or by means of intraocular injections of 25 per cent. argyrol, given once or twice daily. Iced compresses are always indicated and in proper instances blood-letting. A Credé poultice of collargol, applied to the eye at night, is often of decided benefit. Infected corneal or scleral wounds, operative and other, should be touched with the galvanocautery.

In all forms of infection from without we must not ignore the testimony of observers, like Woodruff, who find great benefit from deep, subconjunctival injections of mercury oxycyanide.

Pain sometimes is relieved by iced compresses and full doses of aspirin at night; occasionally, hypodermic injections of morphia are required.

In the milder forms of the disease inunctions of mercury with iodides internally, or large doses of sodium salicylate, certainly assist in checking the progress of the disease. More is expected of this treatment, also, in the localized infections and in those cases of metastasis where the invasion of the posterior chamber is not too virulent.

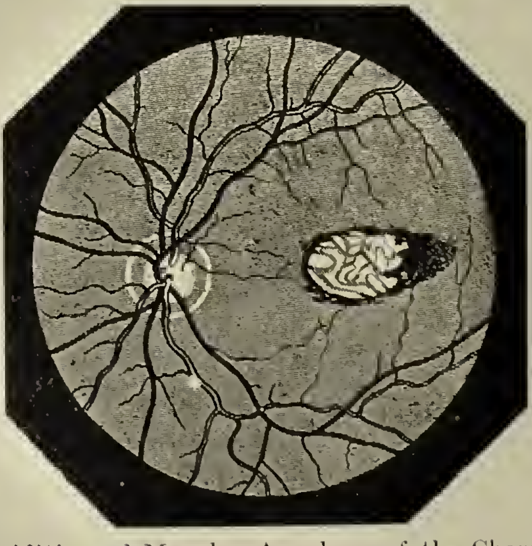
When, in spite of all treatment the disease grows worse, the pain more violent and the swelling of the lid and orbital tissues more pronounced enucleation of the globe is in order. If the edema of the tissues and the other signs of the disease are very marked it is, perhaps, better to incise the cornea, apply hot fomentations and wait a day or so until the emptying of the intraocular abscess gives some relief before doing the complete excision. At the same time I have frequently removed a panophthalmitic eyeball surrounded by a brawny infiltration and edematous lids with great relief to the patient and without any subsequent evidence of involvement of the brain cavity. Yet, it must be remembered that well-authenticated cases of post-operative meningitis are on record.

In the performance of an enucleation it is wise to avoid wounding the conjunctiva any more than is absolutely necessary; symblepharon or cicatricial bands in the conjunctival sac may demand an operation for their repair before an artificial eye can be worn with comfort.

Choroiditis juxta-papillaris is a plastic choroiditis described by Jansen as occurring near the disk and resembling optic neuritis.

Choroiditis, Luetic. See **Choroiditis, Syphilitic.**

Choroiditis, Macular. As Schweizer (*Archiv f. Augenheilk.*, 1890, p. 399) has shown, an inflammation of and exudate into the macular region occurs in about 6 per cent. of all cases of myopia above 10 diopters. In about one-half of these instances both maculæ are affected. In children under ten years of age this complication is



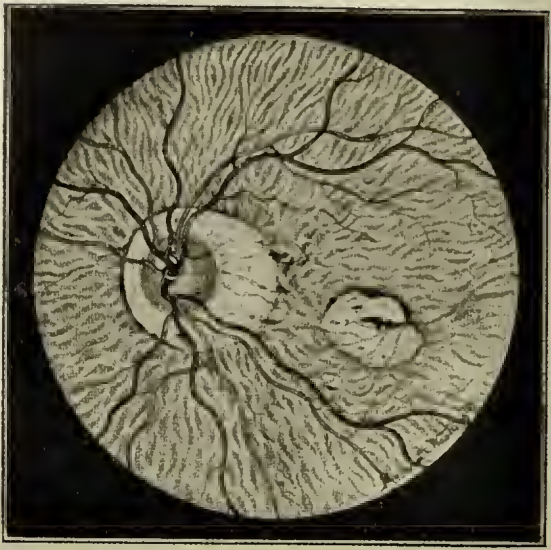
Central Choroiditis and Macular Apoplexy of the Choroid. (Panas.)

rare, but it is quite common above ten, and in preference attacks the female sex in the proportion of three females to two males. As a rule it appears as a circumscribed plaque of a dull-red color, which eventually becomes white, edged with a pigmentary deposit. In some instances similar areas develop throughout the fundus, so that the ophthalmoscopic picture resembles the disseminated form of choroiditis. In 9 per cent. of the cases this condition is associated with vitreous disease, and in 10 per cent. with detachment of the retina. Schweizer does not believe that heredity plays an important part in the etiology of the disease. He thinks that the underlying cause is chiefly a certain delicacy of the macular elements. In a number of instances, also, these central alterations are associated with hemorrhages, and in some they begin with bleeding in the foveal region. This *macular apoplexy* appears early as a blood-red spot which later on is absorbed, leaving several whitish eyelets and pigmentary accumulations. Owing chiefly to implication of the retinal elements the patient's vision is always lowered, although not so much, as a rule, as one would expect from the conditions revealed by the ophthalmoscope.

Choroiditis, Malarial. Choroidal changes of an exudative nature may occur in malaria, generally combined with retinitis. Poncet in the malarial region of Algeria found ophthalmoscopic lesions in 10 per cent. of the cases of malaria.

Choroiditis, Metastatic. See **Choroiditis in general.**

Choroiditis, Myopic. Choroidal changes in myopia are due rather to atrophy than to true inflammation and, as stated by Hirschberg, the lesions are largely mechanical. Schnabel expresses the opinion that many of the changes found in myopia are the result of imperfect development of the choroid, analogous to those seen in a typical coloboma. Pronounced atrophy occurs around the disk, and it is more marked on the temporal side. Stilling attributes this to a displacement of the optic nerve to the temporal side. The sclera of the atrophic area may appear white or may be irregularly pigmented. The atrophic area around the disk was first called a *conus* by Jaeger, and the term *posterior staphyloma* is commonly applied to it, though Schnabel, in his anatomical examinations, found that staphyloma of the sclera occurs only in cases of myopia of more than 8 or 10 dioptres. In high myopia there may be an absence of the pigment epithelium and choriocapillary layer; the larger vessels are exposed and between them are pigmented intravascular spaces. The macular region frequently shows large atrophic areas and hemorrhages may occur. Fuchs describes a condition in which the macular region is occupied



Myopic Choroiditis. (de Schweinitz.)

by a dark mass which gradually becomes lighter in the centre.—(E. K. F.)

Choroiditis, Nodular. Parsons gives this name to a condition in chronic exudative choroiditis, where nodules appear in the choroid. These nodules consist of a localized collection of lymphocytes around the smaller vessels. Leber reported a case which he considered to be due to extension of trachoma, but Parsons regarded it as a chronic choroiditis of syphilitic or tubercular origin.

Choroiditis, Plastic, is that form of exudative choroiditis in which the exudate is of a fibrinous character. See **Choroiditis in general.**

Choroiditis, Plastic embolic. As Weeks says the onset of this disease is similar to that of suppurative choroiditis, but is not so severe. The vitreous is hazy, the anterior chamber is generally shallow, and the ocular conjunctiva hyperemic. The intraocular tension is usually less than normal, but may be slightly increased in the early stage. In the latter stages it is much reduced. See **Choroiditis in general.**

Choroiditis, Posterior sclerotic. A synonymous term for posterior staphyloma, occurring in high myopia.

Choroiditis proliferans. Proliferating choroiditis is a rare condition following injury to the eye. There is necrosis of the infiltrate—a process which may invade every layer of the choroid. Fuchs has reported a case in which the eye had been opened and E. V. L. Brown one in which the eye had been struck with molten metal, but the burning mass had not penetrated the eye coats. The condition resembles a sympathetic infiltration, but in neither case was the other eye involved.

Choroiditis, Purulent. See **Choroiditis in general.**

Choroiditis, Senile, Superficial. As Weeks (*Diseases of the Eye,* p. 373) points out, "Atrophy of the choriocapillaris over larger or smaller areas occurs in adults of advanced years, and is accompanied by greater or less change in, or loss of, retinal pigment over the affected area. Accompanying this there is often obliterating arteritis affecting the arterial trunks of the layer of larger vessels, causing localized atrophy of the deeper structures of the choroid. Peripheral portions of the choroid are most frequently affected. The changes may occur at the posterior pole of the eye alone. It may also develop in a zone concentric to the macula lutea. The walls of the capillaries and small blood-vessels become thickened and their lumen obliterated, the change affecting the choriocapillaris particularly. Retinal pigment disappears and the outer layers of the retina become atrophic throughout the affected area. In the *treatment* of these cases the best results, in the experience of the writer, are obtained by the long-continued administration of the iodides and mercury in moderate doses—iron, if the hemoglobin is below normal, and in proper attention to diet."

Choroiditis senilis. See **Choroiditis, Central.**

Choroiditis, Serofibrinous. This term has been applied by Weeks to that form of acute exudative choroiditis in which there is a pronounced exudation (of a fibrinous nature) into the vitreous.

Choroiditis serosa. Serous choroiditis was one of the terms used by early writers as synonymous with *glaucoma.*

Choroiditis striata. CHOROIDO-RETINITIS STRIATA. This is a rare condition in which yellowish-white or grayish lines are seen running in different directions beneath the retinal vessels. Casper regarded the condition as a final stage of detached retina, and Holden attributed it to retinal hemorrhage. Vision is always reduced.

Choroiditis, Superficial. EPITHELIAL CHOROIDITIS. CAPILLARY CHOROIDITIS. An atrophic condition of the choroid with absorption of the pigment layer and underlying capillaries is a condition described both by Nettleship and de Schweinitz. The larger vessels of the choroid are exposed and between them are seen dark intravascular spaces. It occurs in myopia, in glaucoma and sometimes in degenerative retinal changes.

Choroiditis, Suppurative. See **Choroiditis in general.**

Choroiditis, Sympathetic. This is a lesion that occurs in practically every case of sympathetic ophthalmia. Infiltration appears first around the larger vessels of the outer layer of the choroid and gradually extends to the smaller vessels, and becomes more diffuse. Iridocyclitis usually precedes or accompanies the choroidal changes, though rare cases have been reported with little or no iritis. Alt. (*Jour. Am. Med. Assoc.*, Vol. LIX) described a case where the iridocyclitis was of the mildest type. The iritic spots on the lens, the cloudy vitreous and a blurred condition of the disk all disappeared under treatment. Two months after the onset of sympathetic ophthalmia choroidal changes appeared. The choroidal areas had a sharp outline and some resembled colloid excrescences. Pigment disturbance was not marked but one choroidal hemorrhage was evident. Many of the spots disappeared but a few, small, glistening ones remained.—(E. K. F.)

Choroiditis, Syphilitic. Syphilitic choroidoretinitis. This name is given to any form of choroiditis due to syphilis, inherited or acquired. Förster, in 1874, denied the existence of syphilitic retinitis and described the condition as choroiditis. Schöbl (*System of Diseases of the Eye*) states he has never seen a pure retinitis but rather a chorio-retinitis, though admitting a genuine syphilitic retinitis has been established by Liebrich, Graefe and others. Numerous terms for different varieties have been given, as *diffuse syphilitic chorioretinitis, disseminated and central circumscribed syphilitic chorioretinitis,* or the *"chorioretinitis tumida of Hirschberg."* Hutchinson and Nettleship found a conglomeration of round cells in the choroid closely resembling gummata. Parsons states that syphilitic changes are indistinguishable from those due to other causes and adds that gummata of the choroid are rare: only gummatous infiltrations, generally from the ciliary body, have been observed. Syphilis in the acquired or inherited form is the most frequent cause of exudative choroiditis, but the etiologic factor cannot be determined from the ocular condition alone. By many writers the claim is made that the fine, dust-like opacities in the vitreous, with cloudy retina and involvement of both eyes, are pathognomonic of syphilis. In the acquired form choroiditis rarely appears before six months after the primary infection and may make its appearance in any of the later stages of the disease. Iritis often precedes it and in the acute stages there is marked disturbance of vision from haziness of the retina and cloudiness of the vitreous. When the vitreous clears, the typical choroidal changes of exudative choroiditis may appear. The prognosis under energetic treatment is more favorable than in other forms of choroiditis, though many of the choroidal and retinal changes may be permanent. The *diagnosis* is made from other constitutional symptoms, while the Wassermann and Noguchi tests have proven valuable in determining the etiology. *Treatment* depends on the destruction of the organism and thorough elimination. The reports from the use of salvarsan have not been encouraging; a thorough course of mercurial treatment followed by iodides has given the best results. Before mercury is used the teeth should receive careful attention. Inunction of mercurial ointment: from one-half to two drams should be rubbed into the skin of the axillary space or groin every night, followed by a sponge bath in the morning. This should be continued until signs of hydrargyrism appear. When inunctions are stopped the iodide of potassium is given in increasing doses. After some weeks the inunction should be repeated. The general physical condition of the patient must receive careful attention. Locally, atropine and dionin are indicated, and colored glasses to protect the eyes from the light, while all use of the eyes for near work is prohibited.—(E. K. F.)

Choroiditis, Tay's. See **Choroiditis, Guttate.**

Choroiditis, Traumatic. After a blow or injury to the eye, choroidal macular changes of an exudative nature may in rare cases be the result.

Choroiditis, Tubercular. Tuberculosis of the choroid occurs either as miliary tubercles as a part of a general acute tuberculosis or as a chronic tubercular condition. Miliary tubercles are frequent in general tuberculosis. In 18 cases Cohnheim found them in every one, while Bock gives the percentage over 80, and Carpenter and Stephenson found them in 50 per cent. of their cases. They often appear just before death, and on account of the patient's condition, and the small degree of choroidal disturbance many escape observation. Marple found repeated examination necessary, as in several cases tubercles were found which were not present the preceding day. Both eyes are involved and the tubercles are seen in every part of the fundus though more are present near the disk. They vary in number, usually three or four, but Parsons states that as many as sixty to seventy have been found. They may start in any layer of the choroid, but usually begin in the deep layers, growing from the adventitia of the larger vessels. They vary greatly in size, some minute specks, while others attain nearly the size of the disk. Microscopic examination of the smaller ones shows just a nodular collection of lymphoid cells. The larger ones have the typical structure of a miliary tubercle, consisting of giant cells with peripheral nuclei surrounded by epitheloid cells and a peripheral zone of small-celled infiltration. The vessels in the affected area undergo degenerative changes and the centre of the tubercle is often caseous, and extravasation of blood may occur.

The overlying retina may remain intact except over the larger tubercles, where there is pigmentary disturbance. Tubercle bacilli may be absent or may be found in large numbers. With the ophthalmoscope the tubercles appear as yellowish-white spots surrounded by a rose-colored area with little or no pigmentary changes. The surrounding choroid is unchanged and except over the larger tubercles the retina remains normal. Griffith states that some tubercles are similar in appearance to recent exudative choroidal patches, and would ultimately resemble disseminated choroiditis if the patient were to live long enough. Miliary tubercles are always secondary to advanced tuberculosis. *Treatment* must be directed to the general condition.

Chronic tuberculosis of the choroid occurs as a diffuse inflammation or as a single tubercle. Carpenter and Stephenson called attention to the comparative frequency of choroidal change in chronic tuberculosis. Von Michel and others regard disseminated choroiditis as not uncommon in chronic tuberculosis. Though generally monocular, it is not necessarily so, and too much stress is made on this point to distinguish the tubercular from the syphilitic forms. Like other tubercular conditions, foci of inflammation occur consisting of giant cells with surrounding zones of infiltration. Granulation tissue is formed which may be converted into scar tissue with destruction of the giant cells, and the inflammatory condition is arrested. If the area is in the capillary layer, the retina is included in the scar, and the cicatrix has a deeply pigmented border. On account of weakened resistance or excess of tubercular toxins the inflammation may extend; blood vessels are obliterated and the areas undergo caseous degeneration and necrotic changes occur. Every layer of the choroid may be involved and the sclera is softened and staphylomata are pronounced. The resisting lamina vitrea gives way and retina and vitreous are invaded by the tuberculous material. The whole eye becomes a tubercular mass, with subsequent perforation and extension of the infection. Solitary or conglomerate tubercle is more localized and undergoes similar changes to that described in chronic tubercular conditions. The tubercle is composed of giant cells, in exuberant granulation tissue. Its growth may be arrested and it is converted into scar tissue, or it may advance and give all the symptoms of an intravascular tumor. It is distinguished from a leucosarcoma or a glioma by its yellowish color, the absence of blood vessels and its poorly defined border.

Symptoms of tubercular choroiditis resemble other forms of exudative choroiditis. In pronounced cases iritis, opacities in the vitreous and deposits on Descemet's membrane may be present. *Diagnosis* is made from a thorough systemic examination. The von Pirquet test is apparently free from danger, but the subcutaneous test of tuberculin must be used with caution as with the constitutional reaction the intraocular changes may be more pronounced. The *prognosis* is uncertain since frequent relapses occur after a quiescent stage, and the disease may be progressive. *Treatment* is mainly constitutional and aims to retard the growth of the bacilli, to increase the elimination of the toxins, and to strengthen the resisting powers of the tissues. Good results have been reported from carefully guarded doses of tuberculin. Iodides and mild diaphoresis aid in elimination. Thorough rest combined with out-door treatment should be enforced. Locally, the eyes should be protected from bright light and complications treated as they arise. If the whole eye is involved enucleation is necessary to relieve pain and to prevent further extension of the infection. —(E. K. F.)

Choroid, Leprosy of the. The choroid is sometimes invaded by the lepra bacillus as an extension from the ciliary body.

Choroid, Leucosarcoma of the. This neoplasm does not differ from the ordinary form of choroidal sarcoma, except that it is devoid of pigment, or does not contain as much as that of the ordinary form. Its color, whether light or dark brown, varies according to the amount of this pigmentation. See **Choroid, Tumors of the.**

Choroid, Lymphangiosarcoma of the. See **Choroid, Tumors of the.**

Choroid, Melanosarcoma of the. This tumor has received its name because of its very dark color; in other words, it contains a larger amount of pigment than does the average neoplasm of this kind. See **Choroid, Tumors of the.**

Choroid, Myoma of the. A very few cases of myoma of the choroid have been observed—some of them by Guiata. See **Choroid, Tumors of the.**

Choroid, Nerves of the. Many small branches derived from the ciliary nerves on their way through the suprachoroidea form a plexus in the lamina vasculosa. They are provided with numerous ganglion-cells, distributed singly or in groups, which later on join the fibres of the retina. The ganglion-cells are large and generally multipolar, thus belonging to the sympathetic nervous system. Bietti found a still finer nerve distribution within the plexus. The same investigator discovered nerve-endings in the vessel-walls which had club-shaped or round swellings. He also detected a fine plexus below the lamina vitrea. This points to the conclusion that the nerves of the choroid have principally a vasomotor function. See **Histology of the eye**; and **Choroid.**

Choroid, Neurofibroma of the. See **Choroid, Tumors of the.**

Choroido-iritis. Iritis may be present in many of the forms of exudative choroiditis and it invariably accompanies the suppurative form.

Choroidoretinitis. Chorioretinitis is present in most forms of choroiditis. As the deep layers of the retina receive their nutrition from the capillary layer of the choroid most pathological changes of the choroid affect the retina. Many of the agents that produce retinitis at the same time influence choroidal changes. Nearly all cases of choroidoretinitis described here have been discussed under the heading of various forms of **Choroiditis.** In many of the cases there is marked difference of opinion as to which of the two eye coats is primarily involved.

Choroidoretinitis, Albuminuric. See **Choroiditis albuminurica.**

Choroidoretinitis, Cribriform, is characterized by a membranous sheet of glistening white exudate, slightly raised but lying beneath the retinal vessels, and in which circular or oval perforations occur showing the red beneath, or the perforations may be filled with black pigment. An irregularly pigmented border may surround this area, which chiefly involves the macular region. This condition was first described by Doyne and Stephenson in the *Transactions of the Ophthalmological Society of the United Kingdom* in 1905, where they reported 3 cases occurring with disseminated choroiditis, all binocular. In the *Ophthalmic Review,* March, 1911, Treacher Collins described a similar condition in one eye in a boy of 13, which he thought was the result of an extensive subretinal hemorrhage.—(E. K. F.)

Choroidoretinitis, Familial. See **Choroiditis, Familial.**

Choroidoretinitis, Hereditary. See **Choroiditis, Familial.**

Choroidoretinitis hyperplastica. See **Choroiditis hyperplastica.**

Choroidoretinitis, Luetic. See **Choroiditis, Syphilitic.**

Choroidoretinitis, Miliary. This is the name applied by Theobold to an atrophic condition where the normal red of the choroid and the coloration of the nerve head are blurred. The fundus generally appears as if fine, pigmented grains had been scattered over it.

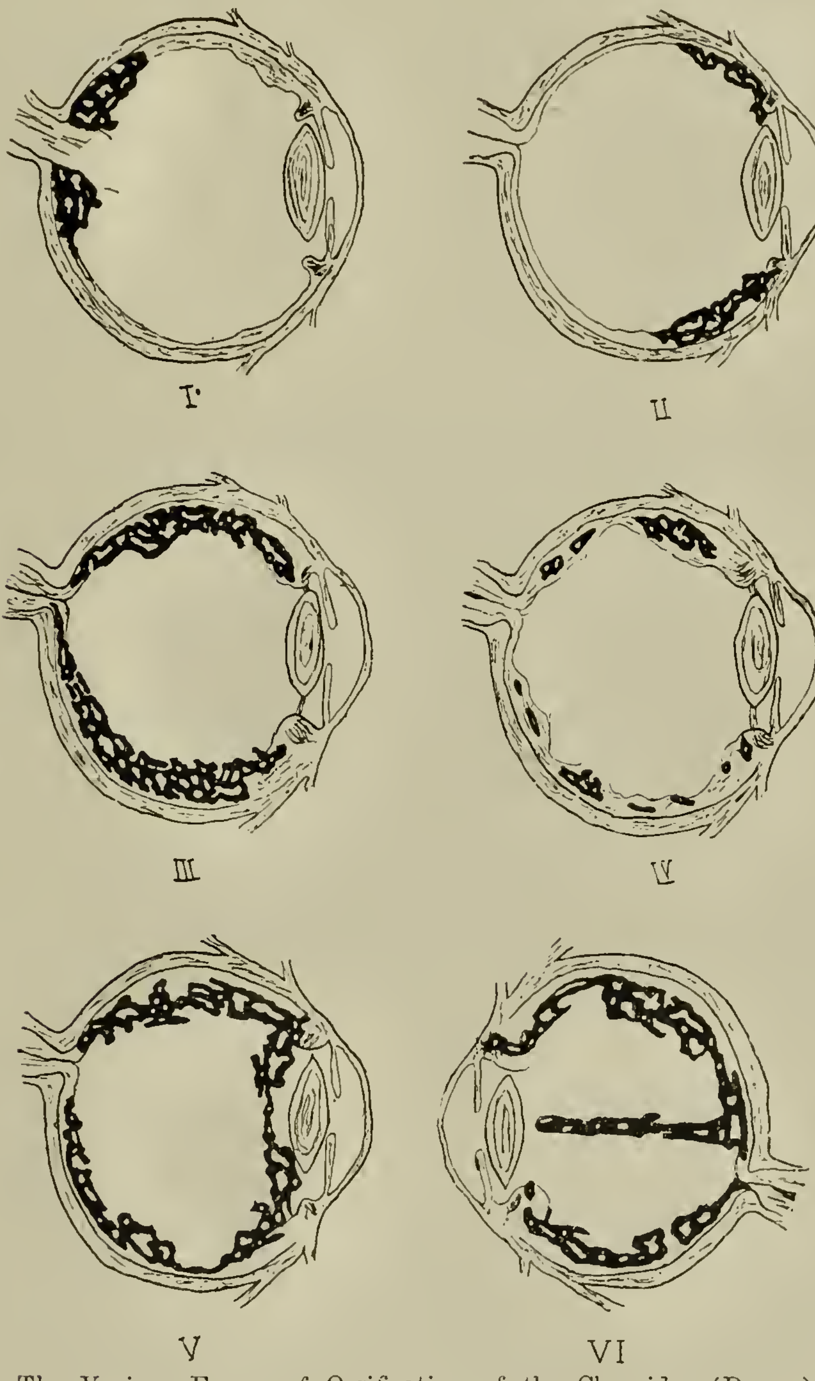
Choroidoretinitis pigmentosa. May closely resemble retinitis pigmentosa. It has been found in glaucomatous eyes that have been removed, and it may appear in extensive syphilitic choroiditis, or as a pronounced choroidal atrophy.

Choroidoretinitis, Specific. See **Choroiditis, Syphilitic.**

Choroidoretinitis, Syphilitic. See **Choroiditis, Syphilitic.**

Choroidoretinitis, Traumatic. See **Choroiditis, Traumatic.**

Choroid, Ossification of the. BONE IN THE CHOROID. Plates of bone are frequently found in atrophied eyes where sight has been lost for years. Rare cases have been reported where bone has been found in eyes that have had extensive choroiditis, or general uveitis, and the bone formation takes place before the bulb is atrophied. As a rule it takes several years for the bone to form, but Schiess-Gemuseus recorded a case where it was found ten months after normal function of the eye, and Buchanan reported one ten weeks after injury. Only small plates may be found near the disk or the ossification may be so complete as



The Various Forms of Ossification of the Choroid. (Bussy.)

(1) Perioptic, annular form; (2) Anterior annular form; (3) Complete cup-shaped form; (4) Disseminated form; (5) and (6) Complicated or atypical forms.

to occupy the position of the choroid. Parsons (*Pathology of the Eye,* Vol. 2, page 481) gives the following description: "The bone may form bars of compact substance, which may be united to one another by smaller bridges, the interstices being filled with granulation tissue, or larger compact masses may be formed with the typical structure of an ordinary long bone, with well developed Haversian systems, the lamellæ with their bone corpuscles being arranged concentrically around the blood vessels. The origin of the bone has been the source of much discussion since Schön's description in 1838. The plausible theory is that the bone develops from the fibrous exudate found in extensive choroiditis, this fibrous tissue replacing the chorio-capillary layer. The ossification is of the periosteal type, and the bone corpuscles that are found in this fibrous tissue may develop from the connective tissues, from the choroid stroma, or from the cells of the capillary walls." Parsons also states that it is the final stage of degeneration of the organized inflammatory deposits and may include the cyclitic membrane; surround the lens, even penetrating its capsule; or may occupy the whole vitreous chamber. Bussy (L'œil osseux; *Revue Générale d'Ophtalmologie,* Vol. 33, No. 1, Jan., 1914) has described and pictured various forms of ossification of the choroid. The accompanying diagrams give a fair idea of the varieties described in the legend.

Treatment is surgical. Since the presence of bone in the atrophied eye is a source of irritation, and is a menace to the other eye, enucleation is advisable.—(E. K. F.)

Choroid, Osteosarcoma of. See **Choroid, Tumors of the.**

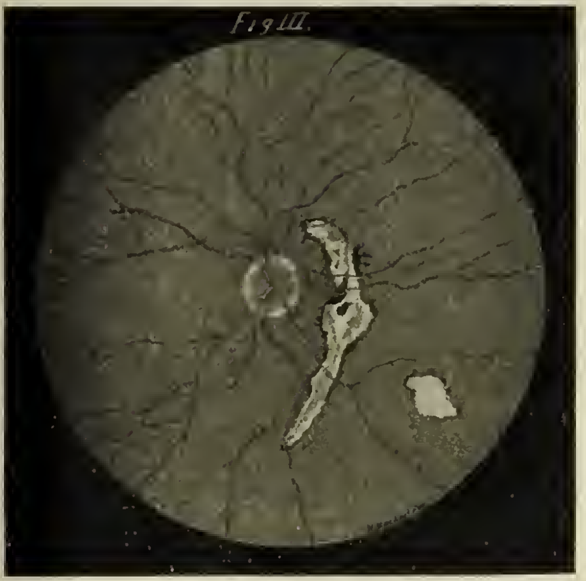
Choroido-vaginal veins. ABERRANT CHOROIDAL VEINS. CHORIO-VAGINAL VEINS. POSTERIOR VORTEX VEINS. These vessels were described first by Schoute in 1898. Coats (*Ophthalmic Review,* Vol. 25) says of them that they occur as large, sometimes enormous, vessels without lustre or reflex, lying behind the retinal vessels; they collect blood from a ramified system extending over a large area of the fundus like the vortex veins; the large trunk formed by these ramifications disappears at or near the edge of the disk; though not confined to one side of the disk, it occurs frequently downward and outward. In all the cases, except one of Schoute's, the eyes are myopic, and in some the myopia was progressive. These veins have been regarded by some as congenital abnormalities. Coats has practically proven in one anatomical specimen that the large vein passed into the optic nerve under the pial sheath. He is of the opinion that they are formed by enlargement of the anastomoses that normally occur in this situation, and this enlargement constitutes a collateral circulation to compensate for a hindrance to the exit of blood by the normal vortex veins. Pictures of these veins appear in the *Atlases* of Oeller and of Haab. —(E. K. F.)

Choroid, Perithelioma of the. See **Choroid, Tumors of the.**

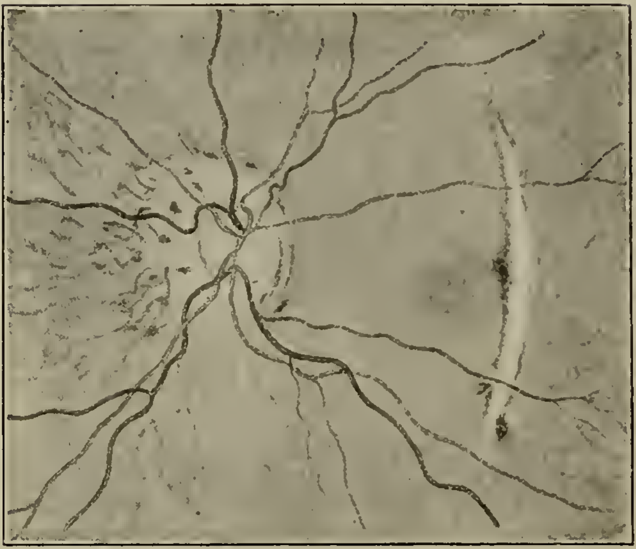
Choroid, Plexiform neuroma of the. This new growth is due to increase in the connective-tissue elements and the presence of nerve fibers and oval bodies resembling nerve endings, as described by Treacher Collins (*Trans. Oph. Soc. U. K.*, p. 25, 1905). See **Choroid, Tumors of the.**

Choroid, Ring sarcoma of the. See **Choroid, Tumors of the.**

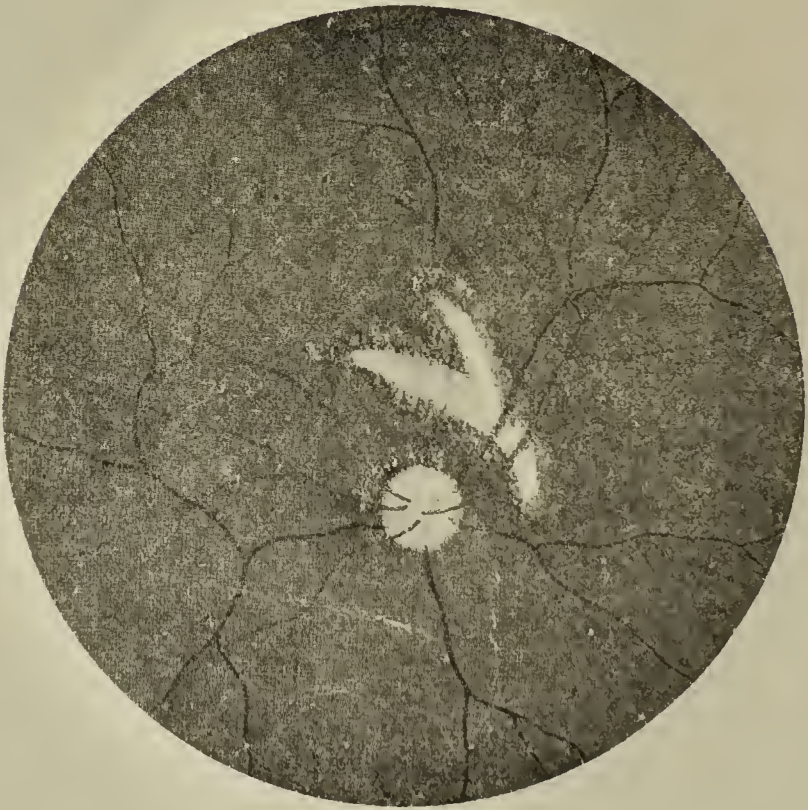
Choroid, Rupture of the. This accident is caused by sudden compression of the eye-ball, usually the result of a blow. It is not uncommon, and the symptoms at the time of the accident are often masked by injury to other structures of the eye. Hemorrhage into the vitreous occurs at the time of the rupture with marked diminution of vision. When the media clear the rupture appears as a yellowish-white crescentic streak with a more or less pigmented borders. If the retina has not been ruptured retinal vessels cross the streak without interruption. Becker attributed the crescentic shape to the following cause: the optic nerve at the moment of impact is driven into the sclera, producing concentrically to the disk a fold or series of folds in the choroid and retina along which the former gives way. The rupture occurs frequently between the disk and macula, but may occur at any part of the choroid. It is not always crescentic. Keiper (*Ophthalmology,* Jan., 1911) described a curious, a typical claw-hammer form of rup-



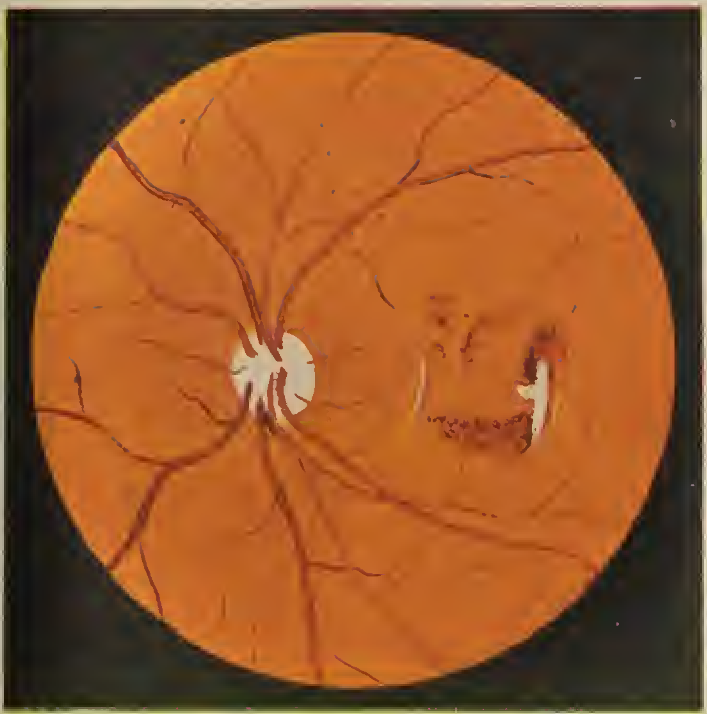
Rupture of the Choroid. (de Schweinitz.)



Rupture of the Choroid. (de Schweinitz.)



Rupture of the Choroid. (Keiper.)



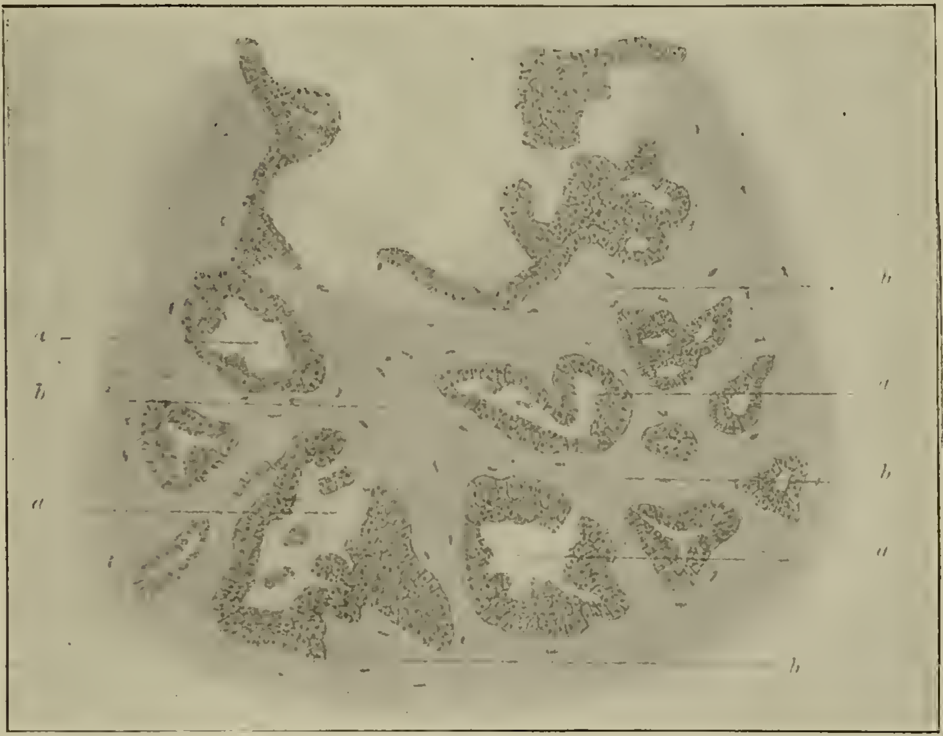
Recent ruptures of the choroid. One week after injury from end of a rope.

ture which is pictured herewith. Todd (*Ophthalmic Record,* 1912) reported a case of rupture, wider than the largest retinal vein, located in the entire horizontal meridian of the eye. The degree of permanent impairment of vision depends on the locality of the rupture and the injury to other structures of the eye. *Treatment* at the time of the rupture is directed to controlling the hemorrhage and keeping the eye at rest. Leeches to the temple, rest in bed, and atropine may be indicated.—(E. K. F.) See, also, **Injuries of the eye.**

Choroid, Sarcoma of the. See **Choroid, Tumors of the.**

Choroid, Telangiectasis of the. See **Choroid, Tumors of the.**

Choroid, Tumors of the. These neoplasms include a large number of tumors also found in other structures; though choroidal growths are not common.

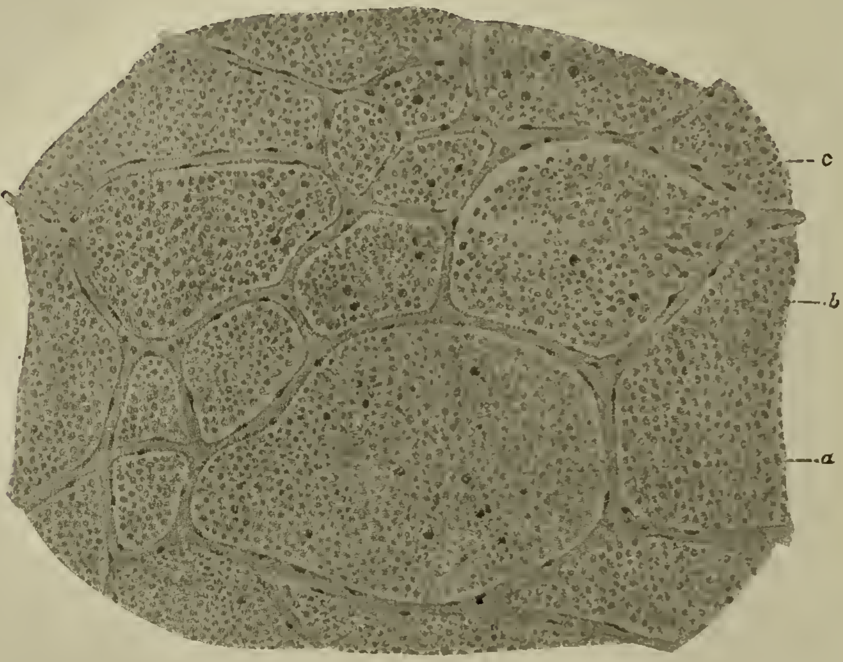


Adenoma (or at least Glandular Tumor) of the Choroid. (Gayet.) a, a, a, Sections of glandular tubules. b, b, b, Fibrous Stroma.

Choroidal tumors may be primary, they may be the result of extension from adjacent structures, or they may be metastases. The alphabetical order is used in the following description.

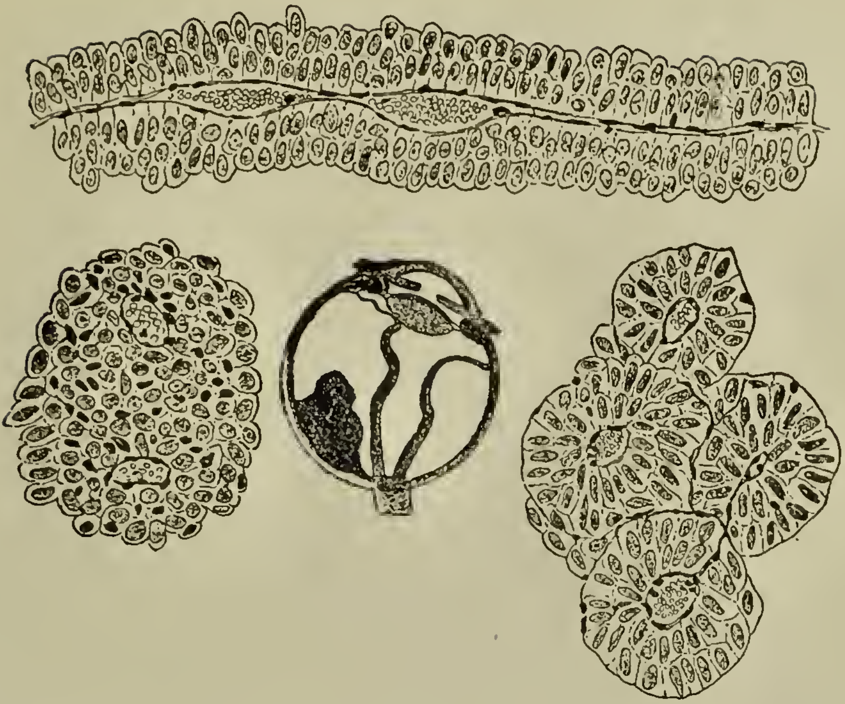
Adenoma of the choroid is not found as a primary growth—the choroid contains no glandular tissue—and is found only in metastasis from carcinoma. See *Carcinoma of the choroid* (*infra*).

Angiocavernoma of the choroid is a cavernous angioma. See *Angioma* (*infra*).



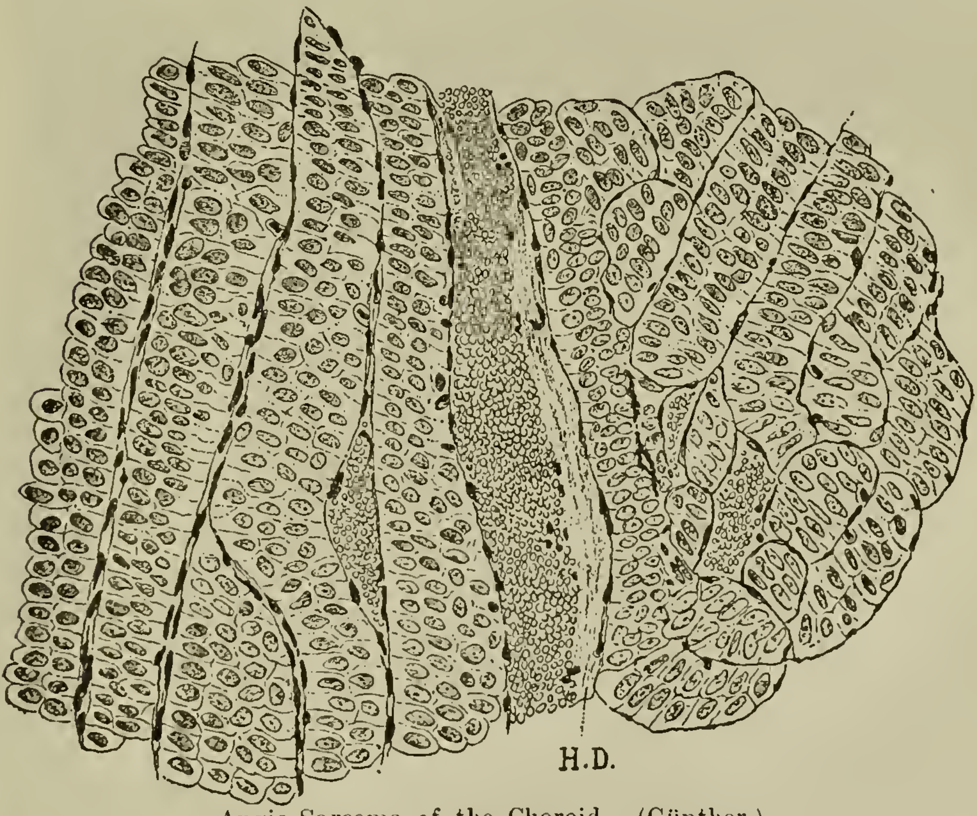
Angioma of the Choroid. (Giulini.)
a, Fresh blood corpuscles; b, c, Partition walls with endothelial lining.

Angioma (nevoid growth of the choroid) is a very rare, congenital condition. Parsons (*Pathology of the Eye,* vol. 2, page 490) gives the following description of it: "The minute structure is that of an ordinary cavernous angioma, and displays much the same varieties. There are large irregular spaces, lined with endothelium, and filled with blood, separated from one another by delicate fibrous tissue. Arteries and veins may be distinguishable in the midst and parts may be composed of dilated capillaries (telangiectasis)." He also adds that the tumor, though it may be found in any part of the choroid, usually occurs in the posterior part, and is flat or lens-shaped, without capsule, and fades off into normal choroid. In several cases of this growth detachment of the retina occurred, followed by secondary glaucoma.



Angio-Sarcoma of the Choroid. (Gunther.)

Cuts showing the position of the tumor in the posterior chamber; histological sections; total detachment of the retina.

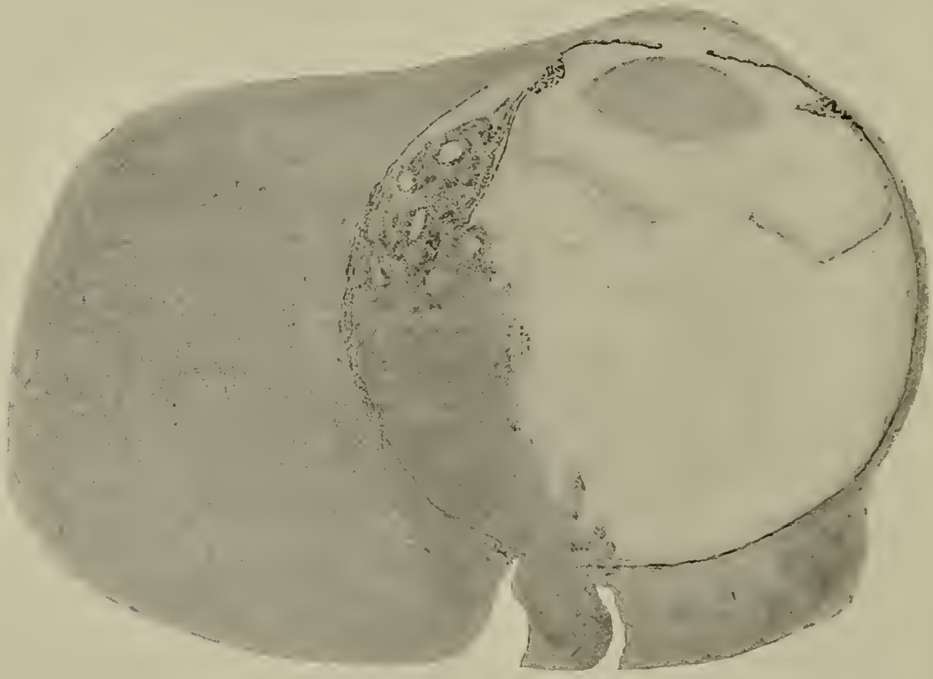


Angio-Sarcoma of the Choroid. (Günther.)

Showing the disposition of the neoplastic cells about the bloodvessels.

Angiosarcoma of the choroid. See *Sarcoma* (*infra*).

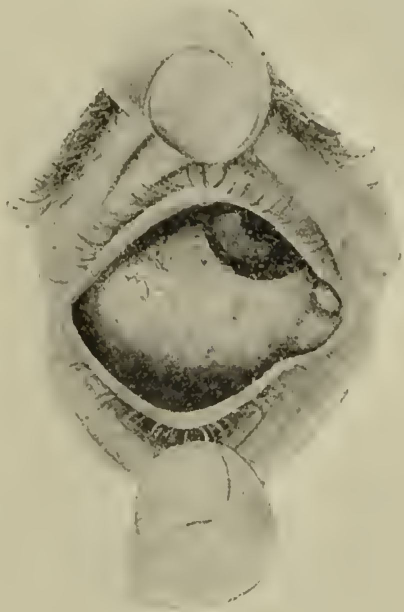
Carcinoma of the choroid is found only as a metastatic condition, as no histologic cells exist in the choroid from which carcinoma could develop. Suker and Grosvenor (*Ophthalmology,* July, 1909) made a study of 64 cases that had been reported up to that date, including their own case. Fourteen were males, 48 females and 2 sex not stated; the average age for appearance was 45.72 years. The youngest was a female of 28, the oldest a female of 61; the average length of life, after the choroidal metastasis was discovered, was approximately seven months; eleven cases survived about one year after the eye invasion; in about one-third of the cases both eyes were involved, though rarely simultaneously; in 50 per cent. of the cases the primary invasion was in the breast. The metastasis assumes the characteristics of the primary growth so it may be medullary, scirrhous, or adenomatous. The metastasis is produced by an embolus carried to the choroid by the posterior ciliary arteries; no case is recorded where metastasis took place by way of the central artery of the retina.



Metastatic Carcinoma of the Choroid.

The intraocular mass, pigmented at his anterior portion, is separated from the extraocular extension by the remains of the infiltrated and disorganized sclera.

Symptoms. When the embolus is lodged the progress of the disease is very rapid and the tumor grows along the line of least resistance. There is never a circumscribed tumor, but always a flat thickening of the choroid. Vision is reduced, and the retina becomes detached but tension is not increased to the same extent as in sarcoma. *Treatment.* Little or nothing can be done, except to relieve symptoms and make the patient as comfortable as possible. Where enucleation has been done, it seems only to hasten the primary activity.



Metastatic Carcinoma of the Choroid. (Lagrange.)
Extensive extra-ocular growth showing beneath the conjunctiva.

Chondrosarcoma of the choroid. See *Sarcoma* (*infra*).

Dermoid of the choroid. Only one case has been reported and that by Follin (*Bulletins de la Société de Chirurgie,* 1861). It occurred in a woman of 70, and was composed of tissue analogous to the subcutaneous structure of the skin, with hair and hair follicles. It was found between the choroid and retina in the upper part of the globe, and was 1.05 cm. in length and 1 cm. in width.

Enchondroma of the choroid is rarely found. It is doubtful if cartilage is ever formed in the choroid. Fuchs however, gives chondrosarcoma as a choroidal tumor in his classification of sarcomata. See *Sarcoma* (*infra*).

Endothelioma of the choroid is a form of sarcoma in which the origin of the cells is from the endothelium. See *Sarcoma* (*infra*).

Flat sarcoma of the choroid, or ring sarcoma, is very rare. Parsons in 1904 collected records of 31 cases. The tumor is not circumscribed but diffuse, and the duration of the disease is longer than in the circumscribed form, and shows a greater tendency to extraocular extension. Parsons regards it is an interfascicular endothelioma. See *Sarcoma* (*infra*).

Granulation tumor of the choroid has been described by Ginsberg (*Centrabl. f. prt. Augenheil.*, vol. 18). It resembles a glioma, but occurred after an exudative choroiditis, and had the characteristics of a polypoid growth. Granulation tumor has been found in the suprachoroidal space by Leber, while Wedl and Bock reported one occurring beneath the *lamina vitrea*.

Interfascicular endothelioma of choroid is an epithelioma the origin of whose cells is from the endothelium lining of the choroidal lymph spaces or clefts in the connective tissue. It is not closely allied to the blood vessels. See *Sarcoma* (*infra*).

Leucosarcoma of the choroid is that form in which no pigmented cells are found. It is said that a pure leucosarcoma, i. e., an entirely and completely non-pigmented growth does not occur. The average occurrence of this tumor is 1 in every 8 cases of sarcoma. See *Sarcoma* (*infra*).

Lymphangiosarcoma of the choroid. For an account see *Sarcoma* (*infra*).

Melanosarcoma of the choroid is that form of sarcoma in which pigmented cells are found. It is the most common type. See *Sarcoma* (*infra*).

Metastatic carcinoma of the choroid is discussed under *carcinoma* (*supra*).

Metastatic sarcoma of the choroid has not been authentically proven. Certain alleged cases have been reported, but none of undoubted metastasis.

It is doubtful whether a true *myoma of the choroid* exists. The case described by Guaita (*Annali di Ottalmologia,* 1895) was supposed to be situated near the *ora serrata,* but was, as Parsons states, in all probability a myoma of the ciliary body.

For a short description of the rare tumor *neurofibroma of the choroid* see *Plexiform neuroma* (*infra*).

Osteosarcoma of the choroid. See *Sarcoma* (*infra*).

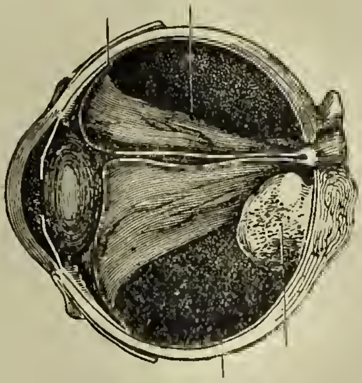
Perithelioma of the choroid is an epithelioma whose cellular origin is the cells from the endothelium lining the perivascular lymph spaces; it is intimately related to the blood vessels. See *Sarcoma of the choroid* (this section, *infra*).

Plexiform neuroma of the choroid—neurofibroma—has been described by Treacher Collins (*Trans. Oph. Soc. of the United Kingdom,* 1903 and 1905) and by Parsons and Rockliffe (*Trans. Path. Soc.,* 1904.) It is a very rare neoplasm and is associated with plexiform neuroma of the lids and various structures of the eyeball. In the reported cases the choroid was thickened and contained oval bodies resembling nerve endings, and an abnormal growth of fibrous tissue was present.

Ring sarcoma of the choroid. See *Choroid, Flat sarcoma of the.*

Sarcoma of the choroid occurs as a single, primary growth, with possibly the few exceptions mentioned under metastatic sarcoma. It is the chief intraocular growth of adult life, and the relative frequency in the various clinics is from .03 per cent. to .06 per cent. of all pathological conditions of the eye.

The *etiology* is obscure; injuries and chronic inflammatory conditions appear to have but little relation to the cases reported. It has been found in all ages, from under ten years to over eighty, although it is more common between thirty and sixty. More cases have been reported in the male than in the female sex, but the difference is not marked, while heredity and environment seem to play no part in the causation.



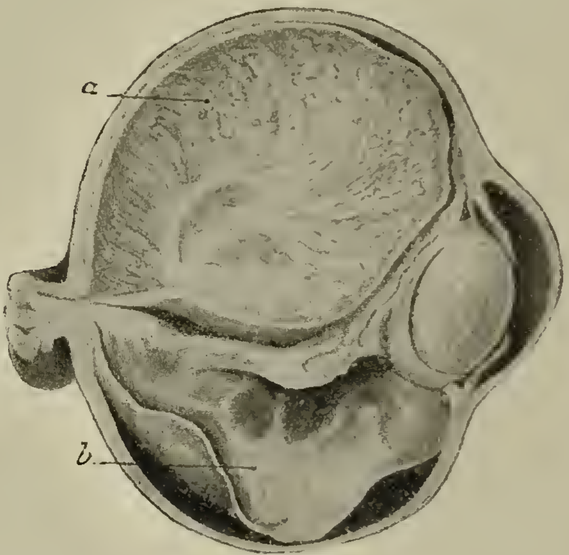
Sarcoma of the Choroid. (After Leber.)

Symptoms may be divided into four stages; (a) early stage, (b) stage of increased tension, (c) extension to the orbital structures when the capsule of the eye is ruptured, (d) metastasis.

The symptoms in the early stage depend on the locality of the tumor and the behavior of the retina. If it is in the anterior part of the eye there may be no disturbance of vision until the retina becomes detached or the media cloudy. It may escape observation for a long period unless the eye be examined under a mydriatic. If it occurs near the macula the vision fails rapidly and under ophthalmoscopic examination the growth may appear as a rounded, knob-like process in an area of pigmentary disturbance. Detachment of the retina of varying degrees and in various localities is frequent. In a few cases the retina remains attached to the tumor, over which the retinal vessels may be seen, while the underlying choroidal vessels may at times be observed.

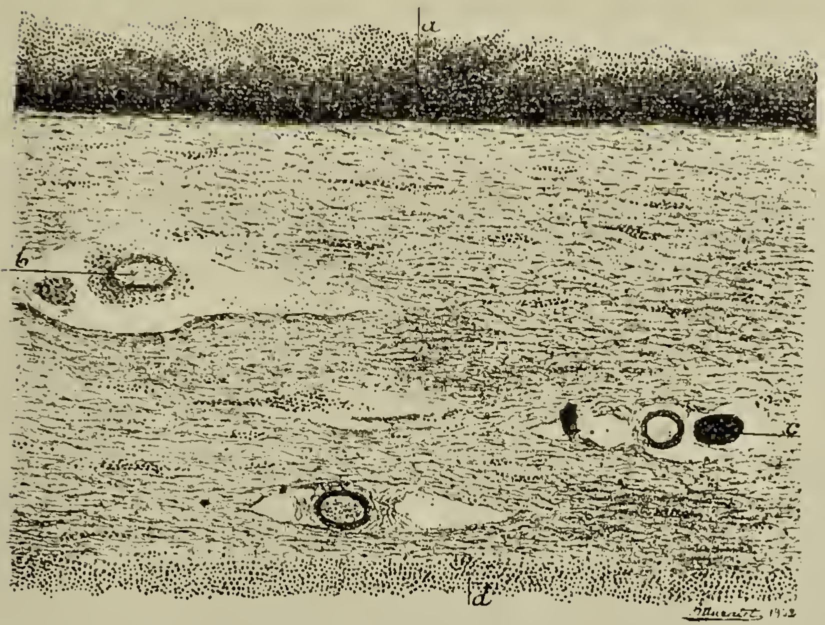
The detachment of the retina does not depend entirely on the size of the tumor, but is mostly due to a serous exudate from the irritated choroid, which may occur in a different locality from the tumor. This stage commonly lasts from six months to a year, but may extend over several years.

In the stage of *increased tension* the usual signs of acute inflammatory glaucoma appear, the cornea is steamy, the anterior chamber shallow, the pupil dilated, and there is pronounced bulbar injection. Parsons (*Pathology of the Eye,* vol. 2, p. 498) speaks of the increased tension as follows: "The detachment of the retina increases, and may become complete, the shrinking vitreous presses the lens and iris forwards, so that the angle of the anterior chamber becomes blocked. The situation of the tumor is of importance, for it may be such as to obstruct the exit of blood by the veins. The angle of the anterior chamber not uncommonly becomes partially blocked by pigmented cells. Less frequently plastic iridocyclitis is set up, bringing increased tension in its train; these eyes may go on to phthisis bulbi. Glaucoma may be precipitated by the use of mydriatics. The second stage is usually shorter than the first—generally less than one year.

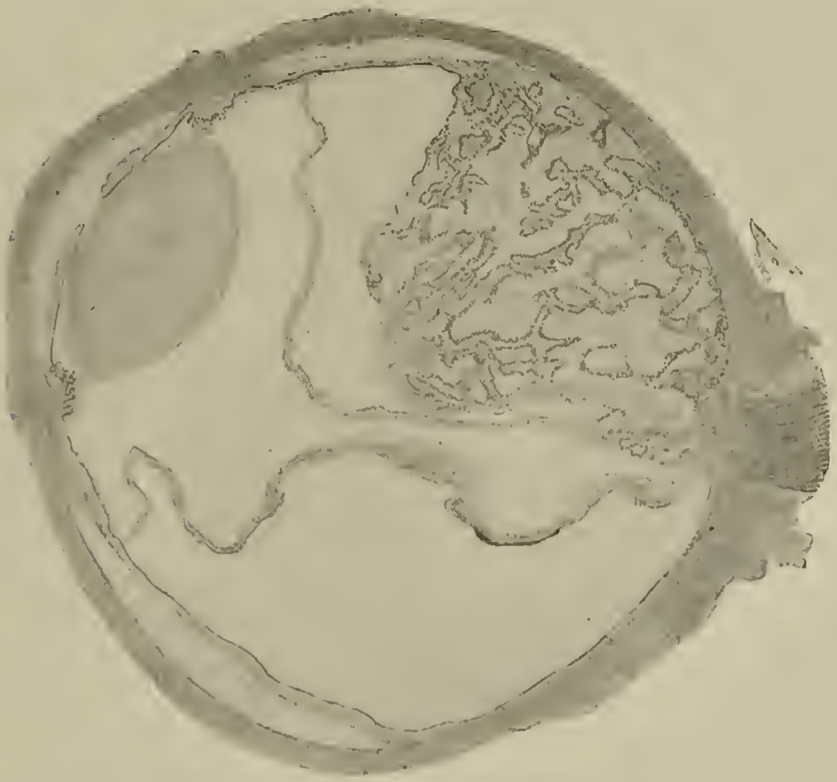


Leuco-Sarcoma of the Choroid. (Lagrange.)
a, Tumor; b, Detached retina.

"When the tumor breaks through the capsule of the eye the tension decreases, and the pain is relieved. The extension occurs along the perforating vessels or by way of the optic nerve. The tumor may appear as a fungating growth or, if it extends along the optic nerve,



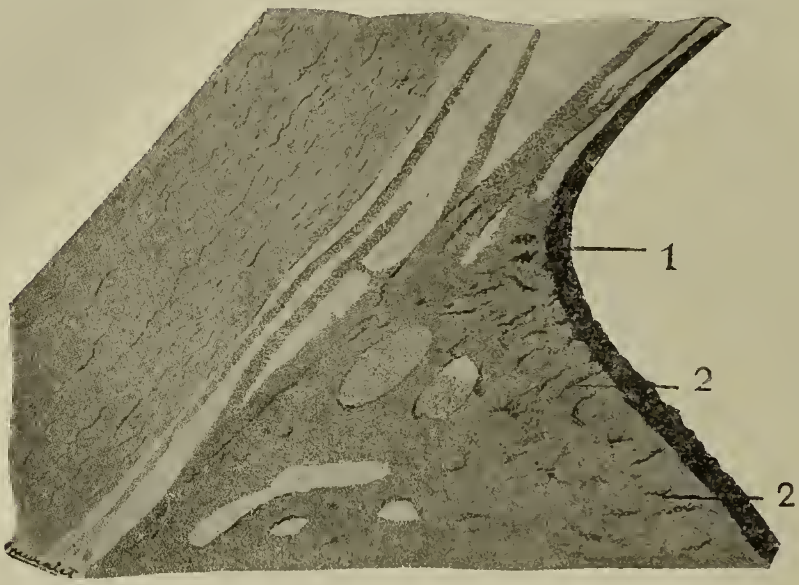
Sarcoma of the Choroid with Extensions into the Orbit.
a, Intraocular growth; b, b, Tumor cells following the course of the blood vessels; d, Extraocular growth.



Angio-Sarcoma of the Choroid. (Kerschbaumer.)
The growth has invaded the retina and the lymph spaces of the posterior segment of the globe.

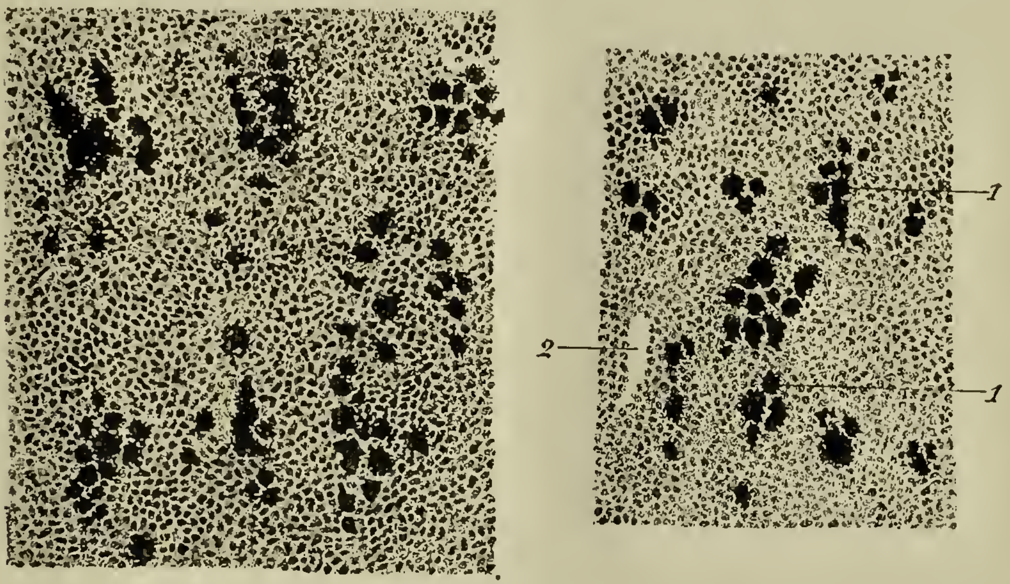
the eye protrudes. The tissues of the orbit are rapidly infiltrated, and there is general extension, or death may result from metastatic involvement of other structures of the body. Metastasis may occur early, and if so, it takes place by way of the blood vessels; even early enucleation has failed to prevent metastasis, which does not appear to depend so much on the variety of sarcoma as on the disposition of the blood vessels. The metastasis may occur to the liver, stomach, lungs or any of the internal organs.

Diagnosis. The character of an intraocular tumor cannot be determined by an ophthalmoscopic examination. In the case of a growth in the eye, even if vision remains, careful observation must be made



Melanotic Sarcoma of the Choroid. (Lagrange.)
The pigment (2, 2,) seems to be a proliferation of or to be derived from the epithelium (1).

from time to time to note any evidence of extension, and when this is manifest, the growth should be regarded as a malignant one. When detachment takes place the evidence of tumor may be obscure. Tension is an important factor at this stage; in simple detachment the tension is either normal or decreased, increased tension is very rare, while in sarcoma if decreased tension does occur, it is only for a short duration, and is soon followed by increased tension. The absence of any cause for detachment should be viewed with suspicion and careful tests made for the presence of a tumor. When glaucoma ensues the history of an attack in an eye that has been blind for some time and the absence of premonitory symptoms of glaucoma, strongly point to an intraocular growth. The usual remission of symptoms that occurs in acute glaucoma is absent in intraocular growths. Griffith (*System of Diseases of the Eye,* vol. 3, page 370) makes the following statement regarding the diagnosis: "If all perception of light be gone and the eye be painful, we should enucleate without regard to diagnosis, as iridectomy is never of any use in glaucoma which has reached this stage; but if some little sight remains it is very desirable to make a diagnosis, and I have found the estimation of the visual field by the candle of some service, the retention of the nasal side being against glaucoma, in which disease, as we know, this portion of the field is always first to go. In spite of all care, however, in the history and objective examination, sarcoma has frequently been found in lost eyes enucleated for glaucoma, and iridectomy has been done in eyes containing sarcoma."



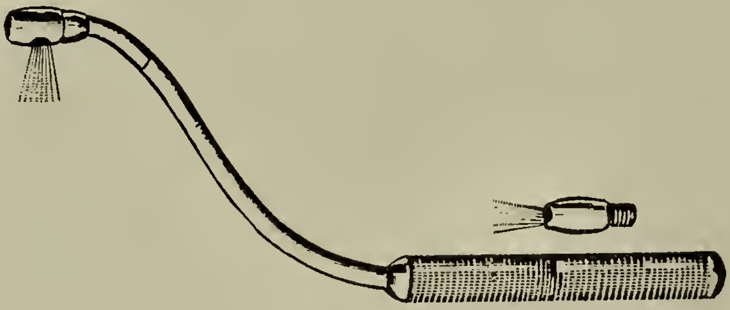
Melanotic Sarcoma of the Choroid. (Lagrange.)

The pigment granules, for example, (1, 1,) in both figures seem to have originated apart from blood vessels, as they are not deposited near the latter, as in (2).

The "tumor shadow" cast by a solid intraocular mass in the skiagram of a Roentgen ray examination is sometimes available for the diagnosis of choroidal sarcoma, or for the determination of a subchoroidal tumor of some sort. The value of the X-ray in these cases has much increased of late years owing to the improvement in technique; and its application should not be forgotten in doubtful cases.

The use of *transillumination* is of great assistance in the diagnosis. For tumors well in front of the posterior pole of the eye, the transilluminator of Würdemann gives valuable information. The eye is cocainized and, in a darkened room, the instrument is placed on various parts of the sclera and the pupillary illumination is observed. If a tumor exists between the illuminated point and the pupil, the difference in the illumination of the pupil is readily seen. For tumors near the posterior pole of the eye the *ophthalmodiaphanoscope* of Hertzell is of great value. It consists of an 80 candle-power electric lamp, strengthened by a reflector to 100 candle-power, and is held by the patient far back in the mouth. A black mask is placed over the face leaving holes for the eyes, and, in a darkened room, the fundus of the eye is well illuminated.

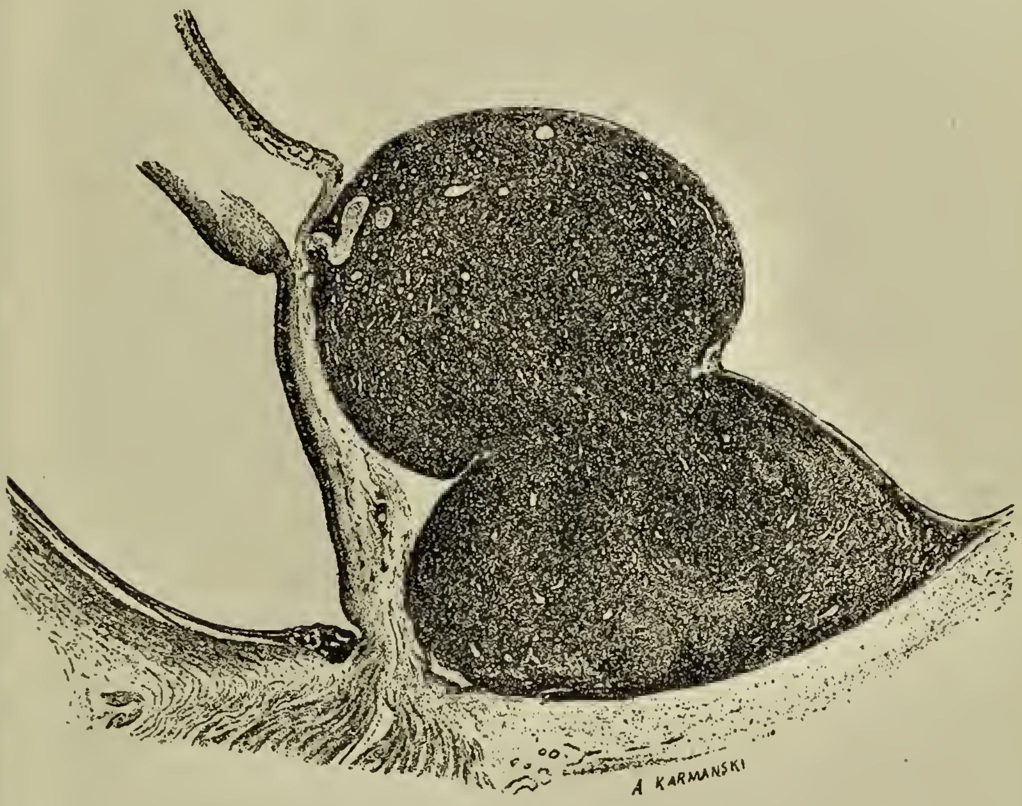
Of probable value in doubtful cases—especially in cryptosarcoma (q. v.)—the posterior ocular *transilluminator* of W. B. Lancaster (*Trans. of the Am. Ophth. Soc.,* Vol. 13, part 2, p. 445, 1913) is not to be forgotten. He describes it as follows: A tungsten lamp is mounted on the end of a copper tube, which contains the necessary insulated wires. The tube is about 3 mm. in diameter and 70 mm. long. Current is supplied by the well-known pocket-flash-light battery. The tube, being of soft copper, can be bent to suit the requirements of the case. The illustration shows one end bent to fit the curve of the globe while the other is bent in the opposite direction to keep the handle from obstructing the view of the pupil. In using the instrument it is necessary to make an opening in the conjunctiva and the capsule of Tenon through which the lamp is passed directly to the point desired. As the method necessarily inflicts more or less traumatism, it is recommended only in cases where the alternative is a more serious operation or perhaps the risk of doing nothing until the diagnosis is unmistakable, a delay which may be fatal. The instrument was demonstrated on a rabbit, and, although the room was not darkened, the pupil showed bright illumination.



Lancaster's Transilluminator.

The diagnosis of a sarcoma was made by Pentscher in a case where there was a *migration of sarcomatous elements* into the anterior chamber. A black mass resembling an old hyphema had accumulated in the lower part of the anterior chamber, some of this when evacuated by puncture of the cornea proved to contain irregularly formed pigment similar to that found in sarcoma.

The term *cryptosarcoma* was given by Schöbl to those tumors whose association with exudates and perineoplastic effusion rendered it difficult or impossible to make a diagnosis. In such cases the eye may be entirely blind, the tension normal or subnormal, the retina detached mostly below, and the subretinal mass largely fluid or semifluid, as shown by the transillumination or X-ray. In spite of negative or favorable findings after enucleation a histological examination may show a choroidal sarcoma partially or wholly concealed by a mass of inflammatory exudation or effusion. Occasionally and in the same way a so-called "pseudoglioma" may conceal a flat or other form of sarcoma.



Bilobar, Juxtapapillary, Melanotic Sarcoma. (Panas.)

The growth is associated with complete detachment of the retina, one part of which is adherent to the inner border of the tumor.

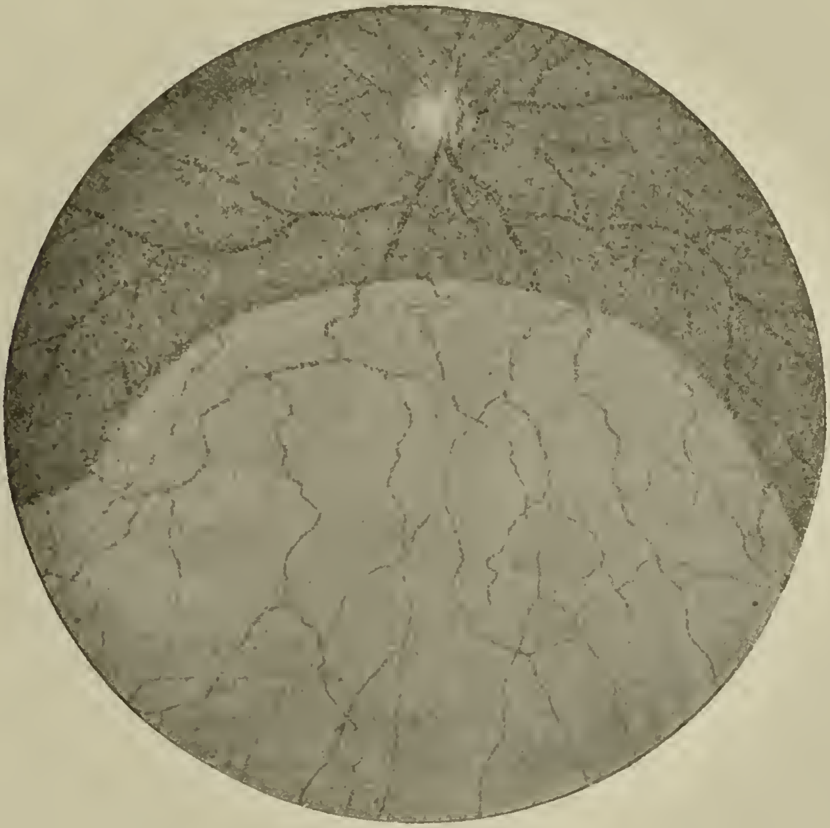
The remarks of J. Moores Ball on this subject are as follows: In making a diagnosis of sarcoma of the choroid the following conditions must be reckoned with:

1. Detachment of the retina and choroid.
2. Neuroepithelioma of the retina.
3. Solitary tubercle of the choroid.
4. Intraocular cysticercus.
5. Glaucoma.
6. Spontaneous rupture of the eyeball.
7. Iridocyclitis.
8. Syphilis with choroidal exudation.

1. (a) Retinal detachment caused by sarcoma of the choroid differs from the simple variety. In the latter the retina, early in the history of the case, is transparent, owing to the absence of the color given to it by the choroidal pigment. Spontaneous retinal detachment is preceded by muscæ volitantes. It appears suddenly, and is accompanied by vitreous opacities, reduced tension, and signs of choroiditis, and often occurs in eyes which are highly myopic. The condition of the other eye as regards refraction, the state of the fundus, and the history of the case are of some value. Holden says that the simple form of retinal detachment extends to the ora serrata, while in tumor the detachment is longer delayed, particularly when the tumor is in the ciliary body or in the posterior pole of the eye. The detachment in the simple form tends to produce folds and show undulations on movement of the eye, while in tumor the folds are generally absent and the mass does not undulate. However, cases occur in which serum collects between a sarcoma and the retina, thus simulating simple detachment and making the diagnosis difficult or impossible. In some of these cases, where the retina is not thickened and the sarcoma is rich in vessels, the tumor may be recognized by the presence of vessels which are neither choroidal nor retinal. As a rule, a large detachment of the retina, pressing against the lens, will be due to an underlying sarcoma. Tension is a valuable diagnostic point: in retinal detachment due to a serous collection it is generally decreased; in choroidal sarcoma it is usually normal at first and becomes increased later. A dilation of the anterior ciliary veins, when localized to one part of the globe, indicates sarcoma, the growth interfering with the return of the blood through one of the venæ vorticosæ. In melanosarcoma the urine sometimes contains melanin, and turns black on the addition of perchlorid of iron.

Bellarminoff's device may assist in making a diagnosis. The eye being anesthetized, a piece of moistened plane glass is pressed against the cornea, thus causing it to become flat and eliminating its refraction. By using strong illumination the opaque sarcoma may sometimes be recognized beneath the detached retina.

Trans-scleral illumination will often enable the surgeon to distinguish between a simple retinal detachment and one which is due to the presence of an intra-ocular tumor. The pupil being dilated and the eye cocainized, the transilluminator is applied at various points on the sclera while the observer notes the effect upon the fundus reflex. Should the pupil remain dark, the diagnosis of an intra-ocular tumor is made. If the pupillary red glow follows the first application of the transilluminator, the latter is moved over the whole area of the detached retina. If no dark spot is found, the diagnosis of simple retinal detachment is made.



Sarcoma of the Choroid. (After Haab.)

In any instance of doubtful diagnosis, the vision being markedly reduced or entirely lost, an enucleation will be justified on the ground that it is better to remove a dozen useless eyes, which are blind from retinal detachment, than to leave a case of choroidal sarcoma till the third stage is reached.

(b) Detachment of the choroid presents even more problems in differential diagnosis. It forms a circumscribed projection, standing out prominently upon the fundus like a sarcoma. The foldings, present in simple retinal detachment, are absent in detachment of the choroid. Usually in choroidal detachment there is hemorrhage and choroidal vessels can be recognized beneath the retinal vessels. Fortunately the condition is extremely rare. Transient detachment of the choroid, following cataract extraction, has been observed by Fuchs.

2. *Neuroepithelioma of the retina.* Here the age of the patient is of importance. Neuroepithelioma is found only in children. While sarcoma of the choroid may occur in childhood, such cases are exceptional. If the media are clear, a diagnosis between neuroepithelioma and sarcoma is usually not difficult. The former presents a yellowish white tumor. A sarcoma, if pigmented, looks much different. In a later stage, when glaucomatous symptoms arise, diagnosis will be difficult.

3. *Solitary tubercle of the choroid* may be mistaken for leucosarcoma. Tubercle, however, does not show vessels, and occurs, for the most part, in young tubercular subjects.

4. *Intra-ocular cysticercus* is of such rare occurrence in this country as to demand no consideration. In the early stages, before the advent of inflammatory symptoms, the picture of cysticercus is characteristic and can hardly be mistaken for sarcoma.

5. *Glaucoma.* The differential diagnosis between sarcoma of the choroid and acute inflammatory glaucoma which has been untreated may be impossible. The author once made an iridectomy for the relief of pain for what was diagnosticated as glaucoma absolutum. Improvement was but temporary; the pain returned and in a few weeks an enucleation showed the case to be sarcoma of the choroid. In such a case the media are opaque, the eye is hard, the episcleral vessels are dilated, and the pain is severe. It will rarely happen in glaucoma that one eye will be entirely blind and the other eye normal.

6. *Spontaneous rupture of the eyeball,* of which the author has observed one case, and Gilfillan and Millikin have recorded others, presents a picture identical with that found in the third stage of sarcoma of the choroid. The history of the case, and the excessive rarity of spontaneous rupture, will serve to clear the diagnosis.

7. *Iridocyclitis.* Here the chief difficulty arises because of clouding of the media, occlusion of the pupil, and opacification of the lens. It sometimes occurs that, in the course of its growth, a choroidal sarcoma will cause choroiditis and iridocyclitis of such intensity as to lead to phthisis bulbi. In a case of idiopathic iridocyclitis both eyes are frequently affected. Tension is usually reduced, while in sarcoma tension is usually increased after the period when the media are clouded. In traumatic iridocyclitis the history of the case will clear the diagnosis.

8. *Syphilis.* Post has recorded a case of sarcoma, occurring in a myopic syphilitic subject. There were floating opacities in the vitreous humor and a projecting mass was seen between the macula and the optic-nerve head. No improvement followed anti-syphilitic remedies. The eye was enucleated and was found to contain leucosarcoma of the spindle-cell type. In this connection it may be stated that Silcock has reported a case of gumma of the choroid.—(J. M. B.)

Prognosis depends on local recurrence and metastasis. Local recurrence is due to extension to the orbital structures and is more likely to happen in eyes where enucleation has been delayed too long. Metastasis may occur early, and is common even after enucleation in the first stage. It depends more on the vascularity of the tumor, and the disposition of the vessels in the growth, than on the cellular character of the sarcoma. Most recurrences take place within two years after operation. It is difficult to get any accurate percentage of recurrence of metastasis. Lawford and Collins traced seventy-nine cases of operation for choroidal sarcoma. Of these forty were dead, twenty-six dying from recurrence or metastasis, and the average duration of life, after operation, was found to be 2 years and 4 months. Griffith states, from his experience, that 50 per cent. may be reckoned as permanent cures after enucleation.

Pathology. Primary sarcoma starts in the connective tissue stroma of the choroid, and, on account of compression from all directions, is at first globular, but when it breaks through the *lamina vitrea* it grows readily in all directions and assumes the knob-like form. Classification of the varieties of sarcoma has not been very satisfactory. The old terms of melano- and leuco-sarcoma are still used to designate tumors with or without much pigmentation. Pigment may be derived from the choroid or retina (autochthonous) or from the blood (hematogenous). The character of the cells in the tumor, whether round, spindle, or giant cells, has also been used in classification.

The tumors are always vascular but the disposition of the new vessels vary. In some cases the cells are arranged around thin-walled vessels, and the term *angio-sarcoma* is used. Parsons, quoting from Coppez, states that there are only lymph spaces in the choroid, so that true lymphangiosarcoma would not be expected, although one case has been recorded by Lagrange. In some cases the origin of the cells is from the endothelium, and this type is known as endothelial sarcoma or endothelioma; that derived from the endothelium of the lymph spaces or clefts between the planes of the supporting connective tissue is termed interfascicular endothelioma, and that from the endothelium of the perivascular lymph spaces is termed perithelioma.

Various changes may occur in the growth, as the development of bone or cartilage, when the term osteosarcoma or chondrosarcoma is used.

Hemorrhages into the tumor are frequent, and in rare cases necrosis may occur. As sarcoma is sometimes found in eyes with phthisis bulbi, it is possible that necrosis of the sarcoma may set up an exudative choroiditis, or the sarcoma may have occurred in the degenerated choroid.

Treatment. Early enucleation is indicated as soon as the presence of an active intraocular tumor is observed. The nerve should be severed as far back as possible. If the orbital tissues show any involvement exenteration of the orbit is imperative. All the contents of the orbit should be thoroughly removed, after which a thorough course of X-ray treatment is advisable.

Telangiectasis of the choroid is a modified form of angioma in which the vascularity is chiefly capillary.—(E. K. F.)

Choroid, Verrucosities of the. See **Choroid, Colloid degeneration of the.**

Choroid, Wounds of the.. These are generally perforating wounds of all kinds and degrees. When they are clean, *incised* and not too extensive, they heal without much permanent damage to the eye. A good deal of hemorrhage is apt to follow *perforating* wounds of the choroid, and if the blood invades the vitreous, fibrous bands may form in the posterior chamber, to be followed, possibly, by detachment of the retina. Panophthalmitis is not an uncommon result of infected choroidal injuries. See **Injuries of the eye.**

Chou. (F.) Cabbage.

Chou-fleur. (F.) Cauliflower.

Christaen, Jean. A peripatetic cataract-pricker of the early 19th century. He was called from Holland to Italy by the Duke of Modena to perform the cataract operation in some Modenese hospital. He has an article in *Annales d'Oculistique* xiii, p. 181-184, 1845. Little else is known about him.—(T. H. S.)

Christ, Ophthalmology of and ophthalmic miracles of. See **Jesus of Nazareth.**

Chroma. Intensity of color or distinctive hue.

Chromascope or CHROMOSCOPE. An instrument for determining the refractive index of colored light.

Chromasia. (L.) The coloring produced by chromatic aberration in the images made by lenses.

Chromasie. (G.) The coloring produced by chromatic aberration in the images made by lenses.

Chromaskiopticon of Cohn. An instrument for exhibiting colors in successive contrast. It is used for the detection of color-blindness.

Chromatelopsia. Color-blindness.

Chromatelopsis. (L.) Color-blindness.

Chromatherapy, Ocular. Treatment of the eye by means of light of different colors. Real or supposed effects of these various hues. See **Blue glass cure**; and **Phototherapy.**

Chromatic. Relating to or of the nature of color.

Chromatic aberration of the eye. The eye is not truly achromatic, as was for a long time believed. This fact is readily demonstrated by the experiment of Wollaston. A luminous point seen through a prism gives a linear spectrum. Making the experiment we observe that we cannot see distinctly the entire extent of the spectrum at once. If the luminous point is at a great distance, the emmetropic eye sees the red extremity of the spectrum as a distinct line, while the blue extremity is enlarged and frequently divided into two. If we go nearer, taking care not to use our accommodation, we find a distance at which we are focussed for the blue extremity, while the red extremity is, in turn, diffuse. The observer can, therefore, determine his *far point* for each extremity of the spectrum; the difference gives the degree of chromatic aberration. Young estimated the chromatic aberration of the eye at 1.3 D., Fraunhofer at 1.5 to 3. D., while Helmholtz gives 1.8 D. The number is difficult to determine exactly since the lowest limit of the visible spectrum is not well defined.

We could correct the chromatic aberration of the eye with a concave lens of *flint*, exactly as we can correct the chromatic aberration of a convex lens of crown glass. The dispersion of flint glass is about three times that of the eye. As the refracting system of the eye is about sixty dioptrics, a concave flint lens of about twenty dioptries would be necessary to correct this aberration. A myope of twenty dioptries, who would correct his ametropia with a flint lens, would have, therefore, at the same time corrected his chromatic aberration. An emmetrope would be obliged to add to this lens a convex achromatic lens of twenty dioptries to remain emmetropic. The attempts which have been made in this direction (Helmholtz, Javal) have not given a very marked improvement of the visual acuity.—(C. P. S.) See, also, **Aberration, Chromatic** and **Color sense and color blindness.**

Chromatic asymmetry. HETEROCHROMIA IRIDIS. A difference in color between the two irides, one being brown or greenish, the other blue or gray. Slight differences in shade between the two irides are not uncommon. When there is a difference in color, almost invariably one iris corresponds in color with the irides of one parent, and the remaining iris with those of the other parent. Instead of uniform pigmentation, a single triangular patch or several irregular spots of dark color may appear upon one or both irides (piebald iris). This condition is sometimes temporary. Chromatic asymmetry, while perfectly compatible with health, has been observed in patients with neuropathic tendencies—chorea and epilepsy (Féré); the pupil of the blue eye may be smaller than that of the fellow eye; physiologic albuminuria may be present (T. Harrison Butler). In many instances there is liability to disease on the part of the lighter eye (cataract, cyclitis); indeed the evidences of cyclitis, according to Fuchs, are nearly always present. For this complicated type T. Harrison Butler suggests the name *heterochromic cyclitis.* Examination reveals punctate keratitis, vitreous opacities, sometimes choroiditis and cataract. The opaque lens may be extracted and the results of operation are usually successful. This phenomenon may appear in several members of the same family. (See de Schweinitz *Diseases of the Eye,* page 64). Discoloration from disease results in one iris being green, that of the fellow being blue, and indicates iritis or cyclitis; it is often an early symtom of inflammation of the iris, and should be looked for in every inflamed eye. When the dark segments seen in a piebald iris are small they have been mistaken by incautious observers for foreign bodies.

Chromatic audition. Color-hearing. Color-sound. Farbenhören. A very interesting and wide spread phenomenon, in which along with an acoustic sensation there emerges also a sensation of color. Color-hearing is the most frequent special case of these phenomena which are known as "synopsias;" that is, a blending of the sensations that are normally two or more sensations. The characteristic of a synopsia is that with a sensation that is produced by one organ of sense, there is combined a sensation which properly belongs to other sense organs—as for example the sensations of taste and smell, light and color, etc. Color-hearing is however somewhat different from the sensation produced by this combination of taste and smell, the psychological discrimination of which is not always precise. But in those cases we are dealing with a unified sensation.

Color-hearing is a phenomenon which gives back the sense-impression unadulterated and unerased and is merely accompanied by the sensation of another sense-organ, that is, color. Color-hearing is an illusion, but not an hallucination, as the phenomenon of light is always attached to the sensation of hearing. But there is an analogy between color-hearing and those "reflex-hallucinations," as Kahlbaum termed them, which result from the stimulation of another sense-organ, as for example, the feeling of constriction of the throat from listening to a hoarse singer, or the itching of a sensitive spot threatening to be touched.

The German word "Begleitempfindung"—accompanying-sensation—best expresses in a single word, the idea of color-hearing. Although there are many people who are subject to this condition, the phenomenon is nevertheless so unintelligible among ordinary people that they regard questionings about their own behavior either as a joke or an insult. On the other hand color-hearers themselves can understand the conception by a single word; they immediately become interested in the subject, after they have tried in vain to speak about it, and have treated it with contempt and irony. Such do not speak spontaneously of color-hearing; they do not volunteer to inform others of their condition as something unusual, as would be the case if it were a matter regarded as an hysterical symptom. Imagination and pretense might play a certain role in this connection, which is so completely beyond control. A critical estimate of the data shows that there is here much more difficulty in offering rational explanations than in other regions of pathologico-physiologic optics, and the skepticism which Daubresse assumes is in a certain degree justified. This author tells of a young Russian who affirmed that he saw all persons in different colors. A lady asked him how she looked to him, and he said "I see you yellow." It appeared that this lady on her arrival was dressed in a yellow gown. The caution which Daubresse demanded in this case was in order, as at that time in the salons of St. Petersburg color-hearing was much talked about, and many Russians claimed that the phenomena occurred with them in similar cases. Ziehen also warned against being too credulous in assuming second-sense impressions, as they only too frequently pretended this condition in order to make themselves interesting. Henning divides the synopias into physiological and psychological photisms. If a color-hearer has a definite, constant color-sensation on hearing the vowel a, this is a physiological phenomenon. If given proper names, or names of the days of the week are felt as color-sensations, without respect to the component elements of these names, this would be a psychological photism.

Whether, in this case, associations are discoverable which are lacking in case of physiological photisms, in which associations optic nerve fibres are stimulated, probably depends on accidents and side-issues. If a piano note appears black, or a violin note wood-brown; if Winter appears white and Spring green, the occasion for this color of the photism may be found in easily recognizable physiological factors, but the capability of the color-hearer, as such, is by no means thereby explained and is quite as obscure as in the case of the photism which Henning calls physiological. If the psychological photisms present merely a subdivision of the physiological, Henning's classification does not seem to be precise enough to distinguish the groups of color-hearers which are actually observed. Consequently Lohmann prefers a dual classification which places less value on the analysis of the photisms than on the persons subject to these symptoms. This division which presents itself very suggestively in pronounced cases, is, however, no more than the other an absolutely sharp distinction; such for example as dividing human beings into artists and not-artists. The first group of color-hearers combine with letters, numbers, proper names, historical names, days of the week, dates of years, seasons, etc., definite and unalterable color-sensations. These individuals have not developed the talent of their special capacity. We may designate the symptoms of this group by the French phrase "audition colorée." In the case of other persons color-hearing constitutes in far higher degree an integrating component of the personality. The incidentally-felt colors play an intimate personal role. For these persons the whole multitude of sympathies and antipathies clothes itself in this garment of the synopsias; their whole planetary life is shot through by this factor in a high degree; they take pride in their distinction which plays such a prominent role in their emotional life, and they endeavor to develop it. For this group Lohmann prefers the expression of Sokolov: "individuation colorée."

Apart from quite rudimentary cases, as for example in persons who on hearing disagreeable shrill noises such as the scratch of a slate-pencil have the sensation, say, of red, and disregarding cases in which color-hearing occurred only in childhood and disappeared later, color-hearing presents a definite phenomenon which tested at different times shows the same unalterable result. The most frequent form is that in which the vowels of the language are seen in bright colors. This phenomenon was stated by a man in rather simple fashion. He said that in case a vowel was spoken loudly and with emphasis he saw the opposite wall colored; in case of ordinary speech this phenomenon did not appear, manifestly because no occasion for his attention in this case was necessary. To him the vowels appeared as follows: a, gray to black; e, light gray; i, red; o, moss green; u, yellow; the diphthongs, ö, phosphorus-yellow; ü, orange (u and i combined).

In music, the harmonies and chords appear bright; in case of minor passages, the wall behind the musicians appeared green, and in major passages, red or yellow. While this particular color-hearer "exteriorizes" his sensations only in accentuated utterances of the vowels, or in the different positions on the scale—that is, feels them as outside of himself. most of the cases which have been observed have the sensation indefinitely in the head. Moreover the sensations occur with them constantly on hearing spoken language. In the literature on the subject it is shown that these phenomena can be made to disappear by diverting the attention. One color-hearer stated that the phenomena seemed to him so habitual and natural that he usually paid as little attention to it as to the ticking of a clock which is so frequently unobserved.

Diphthongs are often seen in mixed colors. For example, a case has been reported in which o appeared yellow; e, red; while ö evolved the mixed color orange. U appeared green to this man; i, yellow, and ü in a mixture of both. In case of au, ai, eu, and ei, in accordance with the vocal prominence of the particular vowels, the colors associated with these vowels came into consciousness. Also in the case of diphthongs we find the same result of color mixing by color-hearers, which appears in a terminal irritation of the eye, a fact which is the more interesting as probably the color-hearing depends upon central irritation of the organs of hearing.

Among others. tones appear according to the sound-color and the instrument on which they are produced. Thus, for example, notes of the flute appear blue, of the violin red, etc. Others again see the days of the week variously colored. To one color-hearer, for example, they appeared as follows: Monday, blue; Tuesday, light-blue; Wednesday, dark-yellow; Thursday, blue-green; Friday, gray; Saturday, brown and Sunday, sky-blue. Proper names also appear colored just as the vowels; so also the numerals may be colored. Others again combine sounds with representations of color. The previously mentioned kinds of color-hearing may occur either separately or combined. in one individual. The constancy of the combination is always emphasized. as Kaiser pointed out in 1882, after he had found in a color-hearer the same result that he had obtained in an investigation ten years previously.

Color-hearing is of frequent occurrence. The statistics of Bleuler and Lehmann showed that 12.8 per cent. of all persons questioned exhibited this phenomenon. Normal persons as well as those of psychic temperaments were observed equally. Ziehen says that color-hearing occurs among the mentally normal. but usually among those of a neuropathic disposition. One may also meet with cases of color-hearing among the blind. For example 10 per cent. even, was observed in the Munich Institute for the Blind. It should be noted, however, that in these cases it is mostly among those who have recently acquired blindness, and in whom for the most part colors could still be made out at short range.

As to the real cause of color-hearing, nothing sure is known.

Stelzner, who gives a circumstantial account of her own case, suspects an abnormal combination of the acoustic and optic centers. Her further arguments are rather too theoretical for discussion here. From our present knowledge all theories on this phenomenon must be treated with reserve.

Flournoy refers to associations, and suggests an "association privilégée," which has once occurred under especially favorable conditions, and has consequently left behind indestructible traces in our nervous system, so that one sensation forever afterwards releases the other. One sense impression may at the same time the more easily release another, the more closely related the two are; that is, if the two arouse the same feeling of pleasure or pain.

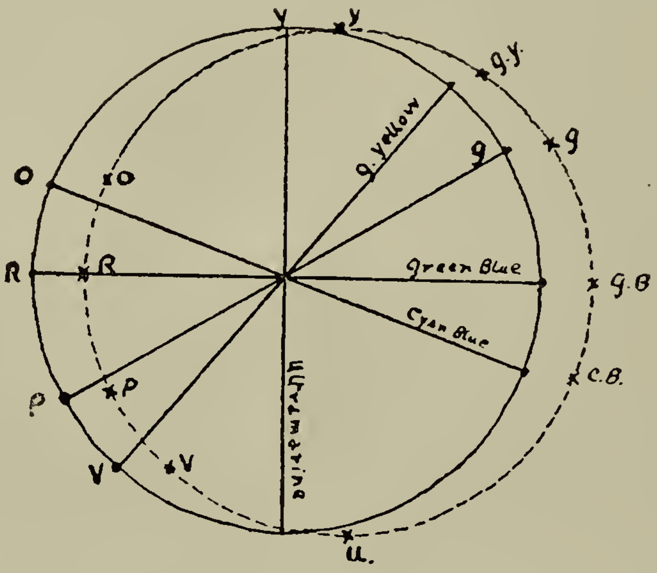
At all events there is no visible reason for assuming that this phenomenon is of an hysterical nature; neither have we any justification in speaking of a psychical contagion—although susceptibility to accompanying sensations is in a high degree hereditary—for the reason that the very opposite of the sensations is observed in members of the same family.

Other synopsias, occurring with the sensations of smell, taste, or pain, etc., are usually associated with color-hearing. A case is recorded of a needle-prick causing the sensation of red. Another, where lemons and lemon juice tasted yellow. One man states that he sees blue when conscious of the aroma of a woman's hair. Hilbert reported the case of a girl who had the sense of yellow when she tasted good milk, while a disagreeable taste gives her the sensation of brown; a very disagreeable taste, gray; and a sweet taste, blue. The poet, Ganghoffer, thus interestingly presents some of the facts of his own case of color-hearing. "When Herr Kerler improvised in changing keys upon the organ, the whole church often took on before my eyes an intensive unified color; everything appeared red, or corn-yellow, or a splendid blue. This never lasted but a few seconds and then disappeared. Usually I saw only a single color and when it had vanished everything returned to its actuality. Yet often if the key which had stimulated a color was suddenly changed, this color also was rapidly transformed into another color which was still more intense. This was always so unspeakably beautiful that a sweet shudder ran through my heart and senses. The color vision of my eyes upon profound influence of good music grew stronger in later years. Up to the present time, however, I am unable to make out any regularity in this phenomenon. But there are a few musical works in which I always see the same color. Wagner's 'Rheingold' always produces a moment in which the whole picture of the stage for a few seconds is suffused with fiery gold-yellow. If I play with my children the final Trio of Haydn, the score toward the end of the first movement is a soft red-violet, which if we without interruption at once begin the Adagio Cantabile is transformed to a deep steel-blue. In the Allegro non troppo of Brahm's C Minor Symphony which I have heard three or four times, I have always seen the same scarlet-red, and once I saw in this color a wide expanse of sky with far-reaching trains of clouds in burning scarlet, above which a tall female figure clothed in deep red seemed to hover.

All passionately felt music transposes itself for me into pictures which I see, while for seconds and minutes I seem no longer to hear the music. Most frequently and intensely are those picture-colors seen with the music of Schumann and Beethoven. Formerly the same was the case with Wagner, but during the last five years the effect which Wagner's music formerly had on me in the way of producing pictures has almost entirely disappeared.'' See, also, **Photism.**—(C. P. S.)

Chromatic circle of Rood. A scheme by which the artist can easily remember color contrasts. To construct this circle we must know the wave-lengths of the various colors which we desire to contrast. The differences in wave-lengths are then calculated so as to correspond to angular differences, these angles being formed by the radii of the circle. Opposite radii join complementary colors and the center will represent white light, i. e., the nearer the center the less will be the saturation of the color. If one such circle, drawn on transparent paper, be superimposed on another, the effect which is produced by contrasting two colors can be readily ascertained. Thus, suppose we desire to determine the influence which red has when contrasted with the other colors. Having accurately superimposed the two circles we move the transparent one so that the point on it which corresponds to red is displaced along the line joining red and its complementary, blue-green. The color on the upper circle will now stand in position on the lower corresponding to the change in hue and saturation which they would have suffered by contrast with red. Thus orange will stand nearer the center and somewhat nearer yellow, whereas green-blue will merely be removed farther from the center, which means that orange will become less saturated and yellower, whereas green-blue will increase in saturation but unaltered in hue.

In general we may say that the effect produced by contrasting two colors is to move them farther apart on the chromatic circle, thus causing mainly a change in hue in the case of colors that stand near one another, but making a change in saturation in those which are far apart.



Rood's Chromatic Circles to Show the Influence of One Color on the Others.

Chromatic dispersion. In *optics,* the difference in the deviations of two colors, or fixed lines of the spectrum produced by a prism exposed to any source of light (See **Achromatism**).

Anomalous chromatic dispersion, dispersion which manifests itself in producing spectra differing from the usual order of colors in the solar spectrum. The spectrum produced by a liquid fuchsin prism shows the colors in the following order: Violet, then follows an interval, then red, orange and yellow in their natural order. Green does not appear, for that color is not transmitted through fuchsin. Such anomalous dispersion is well displayed in most other aniline dyes, and a slight form of it, *irrational dispersion,* is presented in almost all transparent bodies.

Irrationality of chromatic dispersion, the condition in which the ratio of the dispersion of any two colors to the dispersion of the extreme colors of the spectrum is not constant when different media are used. For instance, it may be found that the dispersion of the red region is relatively greater, and at the same time the dispersion of the blue region is relatively less, for one substance than the corresponding partial dispersions of another substance.

Partial chromatic dispersion is the difference between the indices of refraction corresponding to any pair of fixed lines in the spectrum for a given substance.

Mean chromatic dispersion, the difference between the indices of refraction for the light corresponding to two definite lines of the spectrum. *Relative chromatic dispersion,* the ratio between the mean dispersion ($n_f - n_c$) and the difference between the mean index of refraction (n) of the substance and the index of refraction of air ($n = 1$), that is: $\frac{n_f - n_c}{n - 1}$, where D, F and C are the lines of the spectrum.—(C. F. P.)

Chromatic dispersive power. The power of a prism or lens to decompose white light into its spectrum. The refractive index always has a greater value n_b for blue rays than its value n_r for red rays, while for rays corresponding to intermediate portions of the spectrum the refractive index has intermediate values, the mean index being $n = (n_b + n_r)/2$. This value of n will correspond to some point in the spectrum intermediate between the colors red and the blue, and the difference between the deviation d_b for blue rays and the deviation d_r for red rays, or $d_b - d_r = \frac{n_b - n_r}{n - 1} d$, wherein d is the deviation produced in rays for which the refractive index is equal to n. The factor $\frac{n_b - n_r}{n - 1}$ is termed the dispersive power.—(C. F. P.)

Chromatic eye test (Lorenz). So-called CHROMOMETER. This is a patented device of limited value which, however, illustrates one method of using cobalt-glass for the subjective measurement of refraction. As explained in the "directions for use," when a beam of white light passes through a prism it is bent or refracted towards the base of the prism. It is also dispersed or dissolved into the seven elementary colors. These colors are red, orange, yellow, green, blue, indigo and violet. They form what is known as the visible spectrum. If the base of the prism through which the light passes is down, the red will be at the top, and the violet at the bottom of the spectrum, therefore the red rays must be refracted the least and the violet rays the most when passing through the prism. It is this fact that is taken advantage of when using a chromatic test lens as a means of diagnosing errors of refraction.

The chromatic test lens as developed by Lorenz consists of a shade of cobalt blue glass of the proper density to exclude all but the red and blue rays from the eye. The blue rays being more refrangible than the red, are brought to a focus at one point, while the red or least refrangible rays are focused at another point. These two focal points are sufficiently separated to enable a patient to differentiate between them readily. The light used as a test object should be a frosted electric globe. If an oil lamp is used the light should be screened by a frosted lens. The lights used should be inclosed in an asbestos chimney having an iris diaphragm or other round opening. When testing at the usual distance (six meters) the opening in the chimney should be from 25 to 30 millimeters in diameter or about 5 millimeters for each meter of distance. The opening in the chimney should be perfectly round and on a level with the eye to be examined.

The Lorenz Chromometer.

The chromatic lens should be placed in one cell of the trial frame which must be correctly adjusted for both height and pupillary distance so that the patient looks through the center of the test or correcting lenses. One eye must be excluded from vision while the other is being tested.

If an eye be emmetropic, the violet rays will be focused in front of and the red rays back of the retina. The colors will then be perfectly mixed, and the patient will see a violet light surrounded by a narrow blue ring.

If hyperopia exists the patient will report that he sees a blue light surrounded by a red ring. If the eye be myopic, the patient will see a red ring around it take first a minus 50 cylinder in each hand axis tism with the rule be present, the patient will see a violet light with red at the sides. If simple myopic astigmatism with the rule is present, the patient will see a violet light with blue above and below. If mixed astigmatism with the rule be present, the patient will report that he sees a violet center with blue above and below and red at the sides. If the astigmatism is oblique, in other words, if the meridians of greatest and least refraction are not vertical and horizontal, the colors will be seen in oblique meridians. For instance, if the astigmatism be hyperopic and the meridian of greatest refraction lies in meridian 60, the red will be seen in meridian 150 rather than in the horizontal meridian.

If the error be a compound one which requires a sphere and a cylinder for its correction, the meridian of least refraction should be corrected with a sphere. This will necessitate the use of — cylinders to correct the astigmatic error. For instance, suppose the case requires $+ 1.00^s \bigcirc 1.00^c$ axis 90, such a case may be corrected with a $+ 2.00^s \bigcirc - 1.00^c$ axis 180, the $+ 2.00^s$ corrects the meridian of least refraction and over-corrects the other meridian which necessitates the use of a — cylinder.

If the case be myopic the meridian of least refraction requires a weaker lens than does the meridian of greatest refraction. This is the reverse of hyperopic cases.

The axis of the — correcting cylinder must be placed at right angles to the blue seen by the patient or in the meridian in which the red appears if the eye is hyperopic. When the chromatic test lens is used, no fogging is necessary, for the lens fogs the eye completely so that no accommodation except the amount naturally used will be put in force. The following method of using this test is here given by Lorenz:

"*Hyperopia.* If the patient says the light is red on the outside and blue in the center put on plus spheres until there is no more red around it, or until there is a little blue ring around it. This will be the correction for that eye.

"*Myopia.* If he says it is red in the center and blue around it, put on minus spheres until there is no more blue around it or at least only a narrow blue ring, which will give you the total myopia.

"*Hyperopic astigmatism.* If he says it is red on each side or any other meridian, put on plus spherical lenses until the red on each side almost disappears or until there is only a little red on each side, then put on minus cylinders axis where the red is until the red appears at right angles to the axis of the cylinder, in other words, until you have a red ring around it. Be sure and not get the red longer the other way, for if you do you will over-correct the astigmatism. If you have a red ring around it take first a minus 50 cylinder in each hand axis at right angles and hold one in front of the eye first axis 90, if he says the red is now longer on each side, then put on the other cylinder axis 180, and if he says then that it is a little longer on the top and bottom, you have your astigmatism properly corrected. This is in the higher degrees. In low degrees or in small amounts of astigmatism you should use quarter diopter cylinders to verify your findings regarding the astigmatic correction. Then put on plus spheres until there is no more red around it or until there is a little blue ring around it—that will give you the proper correction. If it is red on one side only or above or below, that does not mean astigmatism, it means that the patient is not looking through the center of your correcting lenses, or if so, it means that his eye does not refract equally in all meridians.

"*Myopic astigmatism.* If the patient says it is blue up and down, it is myopic astigmatism with the rule. Put on minus spheres until you have a little red on each side and then minus cylinders with the axis where the red is until you get a red ring around it as before.

"If you have a perfect red ring around it then reduce your minus spheres until there is a little blue ring around it and that will give you the full correction.

"*Mixed astigmatism.* In mixed astigmatism, the patient says it is red on each side and blue up and down, you then put on plus spheres until there is but a little red left on each side and then minus cylinders axis where the red is until you have a red ring around it, then add plus spheres until there is no more red around it.

If a patient be both red and green blind it will be difficult to refract him by this method. It is also difficult to refract successfully where there is a high degree of myopia 8 diopters or more. If the patient is highly myopic he should approach the light to within 4 or 5 meters. This reduces the diffusion of the light. The green and the red and green blind amount to less than 5 per cent. of all cases and the myopes of high degree are also less than 5 per cent., therefore more than 90 per cent. of refractive errors may be successfully corrected by the aid of the chromatic test."

Chromatic polarization. Polarization attended by a peculiar and unusual display of colors.

Chromatics. The science of colors; that part of optics which treats of the properties of colors and colored bodies.

Chromatic thermometer. Arrangement of glass plates, so adjusted as to show the difference between their temperature and that of an object with which they are brought in contact. This is accomplished chiefly by the varying hues of polarized light produced in them.

Chromatism. (Obs.) Chromatic aberration.

Chromatoblast. Same as chromatophore.

Chromatodysopia. Color-blindness.

Chromatogenous. Producing color.

Chromatograph. An instrument used to produce different shades of color by the simultaneous rotation of colored segments.

Chromatography. A treatise on colors.

Chromatology. The science of colors; the scientific investigation of matters pertaining to color.

Chromatometablepsia. (L.) Color-blindness.

Chromatometer. An instrument for measuring the intensity of colors. See, also, **Chromatophotoptometer of Chibret.**

Chromatometry. The estimation of the coloring power of a substance.

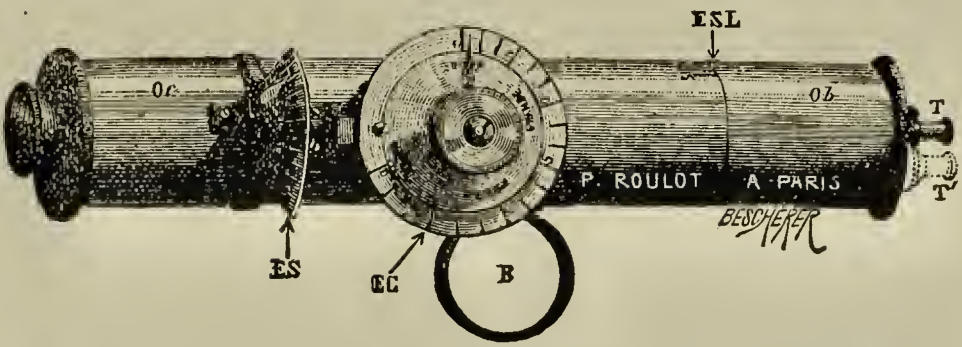
Chromatophobia. Abnormal sensitiveness of the eye to certain colors of the spectrum: the erythrophobia or "fear of red" noticed in some hysterical subjects.

Chromatophore. One of the pigment-bearing sacs with contractile walls by which changes of color are effected in various animals, as in chameleons and cephalopods.

A plate of a brownish-green color found in diatoms and colored with diatomin.

One of the brightly colored bead-like bodies situated in the oral discs outside the tentacles—as in certain actinias.

Chromatophotoptometer of Chibret. A polarization instrument used for the detection of color-blindness. A plate of quartz cut parallel to the axis is placed between two Nicols, parallel to each other and forming an angle of 45° with the axis of the quartz. The plate will be seen tinted a certain color which depends on the thickness of the quartz. Making the Nicol nearest the eye (the analyzer) rotate around the axis of the tube, the color becomes less and less pure. At 45° the field is white, and if we continue to rotate the Nicol we obtain the complementary color, which increases the purity, up to 90°, when it attains its highest point. Replacing the analyzer by a double refracting crystal, a plate of spar, for example, which acts like two Nicols, perpendicular to each other, the field is seen double and one of the images of the field has the color complementary to that of the other. Rotating the spar, the colors become less and less pure, and at 45° the two



Chromatophotoptometer of Chibret.

fields are white. The hues of the two complementary colors depend on the thickness of the plate of quartz. In the instrument of Chibret, by placing the plate more or less obliquely, we can use a greater or less thickness, and thus obtain the whole gamut of colors. The instrument thus presents a very great number of hues and degrees of purity.

The patient looks towards a window through the instrument. We place the index of purity ES, which regulates the position of the doubly refracting crystal at 5′, which gives colors strongly mixed with white, and after having put the index at the hues EG, which regulates the inclination of the quartz on the orange, at zero, we ask the patient if the fields are alike. If they are not, we rotate the index of the *hues* slowly towards the red, yellow and violet. If the patient always sees the two fields different we repeat the experiment after having placed the index of purity at zero, which makes the two fields white. He ought now to see them alike. If the patient stands these tests he is not color-blind. If, on the contrary, in the first experiment he sees the two fields alike for a certain hue, he is color-blind. We then increase more and more the purity of these hues. If we thus succeed in producing a difference between the two fields the daltonism is incomplete; in the contrary case, it is complete.

If there is a question of persons who seek employment on railroads, or as sailors, etc., it may, in addition, be useful to examine whether they can distinguish signals. An aperture of 3 millimeters diameter in a screen, covered with white paper, and illuminated from behind by a lamp, suffices for this examination. We place the person to be examined at 5 or 6 meters distance, and we see whether he commits errors when we place glasses of different colors before the aperture. See **Color sense and color blindness.**—(C. P. S.)

Chromatopsias, Toxic. In contra distinction to the so-called genuine chromatopsias (see **Chromatopsias, Genuine**) some authors speak of colored-vision from toxic drugs, of infective origin, or from certain diseases, although it would seem to be a distinction without a difference. The form of color vision most frequently seen is xanthopsia, or ''yellow seeing.'' Of the various drugs which may produce this phenomenon, santonin is the most notorious. A deep yellow tint is imparted to everything in the range of vision; sometimes yellow is replaced by green, and it is stated that the tint may be red or blue. According to Knies, the yellow seeing appears in from ten to fifteen minutes after the toxic action of the drug sets in, and is preceded by a period of ''violet seeing.'' Ophthalmoscopically there are no changes, and the central vision and the pupillary phenomena are normal. Retinal adaptability, however, is diminished.

Other drugs which produce this symptom are nitrite of amyl (Peck, Landendorf), picric acid, chromic acid, when it is used as a local application, digitalis (Jeanton), which may also produce mydriasis and nebulous vision, carbonic oxide (Hilbert), and tobacco (Simi and de Schweinitz). Cannabis indica may cause violet vision (Werner), and coffee, red vision.

Chromatopsia accompanying malaria. Disturbances of the color sense occurring in malaria are probably of central origin.

Chromatopsia from Anhalonium Lewinii. Preparations made from this variety of cactus are used by some of the native tribes of Northern Mexico as an intoxicant. Following its use, rapid dilatation of the pupils occurs, with other ocular symptoms, followed shortly by visual hallucinations which are said to be even more remarkable than those produced by haschisch. These consist of distinct panoramic color effects and rapid kaleidoscopic color changes. Those addicted to this habit describe the sudden appearance in the field of vision of "tubes of glistening lights which carry green or red balls that roll about continually." Other forms—letters, figures, etc.—show themselves lighted by the most brilliant colors of the spectrum. Objects at first appear violet, then green and golden yellow. By gas illumination there is an increased perception of light, and shadows are violet colored; in electric illumination there are peculiar wave-like movements of objects. See **Anhalonium Lewinii, Oculo-toxic symptoms from.**

Chromatopsia after atropine. Color-vision, especially the erythropsia following cataract removal, after the use of atropine is not infrequently seen. But red-vision often follows this operation where atropine has not been used, and even in perfect health under different conditions. It is possible that this form of color-vision depends upon local trophic changes for its cause, as in general poisoning. Subjects of this anomaly complain of hallucinations of vision and photopsias; they see objects iridescent, or surrounded by a white cloud, or colored yellow, blue, red or green.

Chromatopsia after cannabis indica. Chromatopsias may occur, in very different degrees, among persons, either sick or healthy, who have taken this drug. As small a quantity as 0.04 gm. has produced violet vision as well as the psychic excitations. Two gms. of the extract in one case produced pleasing color hallucinations, objects being chiefly blue and green. A physician, after having taken 0.3 gm. of Indian hemp experienced first an obscuring of vision and objects appeared to him in flaming colors, later a blue light, while they also seemed to grow to enormous dimensions.

Chromatopsia after sodium bromide. Chromatopsias not infrequently follow the taking of bromides.

Chromatopsia from alcohol. Disturbances of the color sense which are so frequently seen in connection with chronic alcohol poisoning, are only occasionally met with in the acute form. A case is recorded of a forty-four year old man who after a severe attack of acute alcohol poisoning saw all objects blue. This condition persisted for four days.

Chromatopsia from poisoning by carbon disulphide. Amblyopia and various forms of chromatopsia are frequently produced by inhaling the fumes of this poisonous agent, all of which will be fully considered under **Toxic amblyopia.**

Chromatopsia from cocain. Among persons addicted to the use of cocain, Laury (*Annal. Med.-Psychol.,* 1889, p. 43) observed defective color sense as one of the symptoms.

Chromatopsia from lead. The color sense, in this condition, shows a lowered functional activity. One, for example, while retaining the sensation for blue might not be able to recognize red and green with accuracy, the former might appear green and the latter yellow. In another case there might be a disturbance of the color sense in only one eye. With this eye small spots of green would not be recognized, faint spots of green appearing as gray. Even a general weakening of the red and green sensations, or a loss of green sensation in one eye, and a confusion of blue and green with the correct perception of red in the other eye; even a complete loss of color sense has been observed. According to Dodd (*Trans. Ophth. Society of the United Kingdom,* March 8, 1900) subjective color-sensations from lead are apparently very rarely seen. See **Toxic amblyopia.**

Chromatopsia from hyoscyamin. Red or scarlet vision was seen (*Ephemerin. Nat. Curios.* III, 2, p. 115) by Hühneswolf in nine persons, including children, after the internal administration of the root or seed of hyoscyamus niger. This condition occurred during the convalescence from the intoxication.

Chromatopsia from metabolic poisoning. It is alleged that red and yellow vision can occur in poisoning from "spoiled" food. Only one case, however, has been recorded by Lewin and Guillery, in which objects were seen in an altered color, namely a greenish appearance.

Chromatopsia from opium. From what is already known concerning this form of intoxication it is an irrefutable fact that chronic opium and morphine poisoning, and probably acute poisoning also, can produce central scotoma, concentric contraction of the field of vision for white and colors, and disturbances of the color-sense. Thus, in one person black letters appeared as red, and red and green as gray; and in another carmine and yellow were not recognized at all. The origin of the scotoma might, perhaps, be traced back to some pathological change in the papillo-macular bundle of the optic nerve fibres.

Chromatopsia from santonin. It has been known for more than a hundred years that santonin possesses the property of causing yellow vision. Calloud, in 1846, was the first to describe this condition. In Germany the first cases of disturbance of the color sense by santonin were observed in 1852. See **Toxic amblyopia.**

Chromatopsia from scopolamin. Persons suffering from this form of poisoning notice a mistiness of vision; objects appear to be drawn out or lengthened in their proportions. Before the closed eyes of those in a scopolamin sleep there appears a black circle upon silver, or a green upon a golden base.

Chromatopsia from tobacco. A diminution of visual acuity occurs from tobacco, just as from alcohol; also the same disturbances of the color-sense. This subject will be fully discussed under **Toxic amblyopia.**

Chromatopsia from thiosinamin. Colored vision sometimes follows the internal administration of this drug, accompanied by severe headache and giddiness, nausea and vomiting, without any pupillary changes.

Chromatopsia with facial erysipelas. There have been not infrequently observed in this condition a concentric contraction of the field of vision, or a defect above, or a central scotoma, or even a temporary loss of vision for red and violet. Exceptionally, peculiarities of color vision have been seen, flaming and scintillating vision, according to Lewin and Guillery.

Chromatopsia from influenza. A number of cases of blue-vision and yellow-vision have been reported, occurring during the course of influenza. In one case, that of a thirty-eight year old man who had a severe attack of influenza, dizziness came on in a few days. After several days he had blue-vision, the whole visual field and all fixed objects appeared a dark cobalt-blue. In the eyes were no abnormal findings. Under sodium bromide, iron, and limited diet, within fourteen days both the dizziness and blue-vision disappeared. It would be a question here, whether the cause of the disturbance was the weakening of the nerve centres through the sickness, or an irritation of certain brain centres from the toxic elements.

The chromatopsia can last very different lengths of time. For instance, in one case it appeared at the height of the illness and remained for only two hours; in another case forty-eight hours; in still another, four days. A sixteen-year old girl observed in the course of an influenza, that in the centre of the right visual field a bluish-green spot appeared, that persisted for eight or ten days.—(C. P. S.)

Chromatopseudoblepsia. (L.) Color-blindness.

Chromatopseudopsia. (L.) Color-blindness.

Chromatopseudopsis. (L.) Defective color sense.

Chromatopsia. Abnormal sensation of color, or chromatic vision, in which all objects appear of the same unnatural color. It may be congenital, or due to disorders of the optic centers or to drugs. See **Chromatopsias, Genuine.**)

Chromatopsias, Genuine. Our knowledge of *genuine* colored vision has been largely increased, during the past sixteen years especially, by Hilbert's study (*Klin. Monatsbl. f. Augenheilk.*, Apr., 1913) of a considerable number of cases. The list includes red-vision, yellow-vision, blue-vision, green-vision, and even black-vision.

Red-vision. Erythropsia. A number of investigators have described cases of pathological red-vision; that form seen after cataract extraction; red-vision in connection with other forms of sickness, and red-vision in connection with the gradual fading away of the color. One unilateral case lasted for two and a half years, and disappeared through animal magnetism. A case of red and green vision in an epileptic has been described, and a case of dazzling red-vision from the effect of electric light in the eyes. The first authentic description of red-vision following cataract operation occurred in 1753, as Hirschberg has pointed out.

Yellow-vision. Xanthopsia has occurred as an accompanying symptom in cases of intestinal parsites; from the effects of intense electric light; in a fatal case of Weil's disease; in influenza, and in various nervous disturbances; one case after a preliminary iridectomy; and one case accompanying the nephritis of pregnancy in which there was seen opthalmoscopically a slight edema of the papilla, but most of them from santonin poisoning (q. v.).

Blue-vision. Cyanopsia. This anomaly has been observed in connection with optic nerve and retinal atrophy; as an epileptic aura; after cataract operation; in influenza; after an apopletic seizure; in connection with macropsia and metamorphopsia, as well as numerous other nervous symptoms; in arterio-sclerosis of the retinal vessels; and following an excess in alcoholics. Blue-vision cases have been reported by de Kleijn (and one patient complained of seeing red balls of fire) in tumor of the hypophysis.

Green-vision. Chloropsia. Up to the present time only a few cases of green-vision have been observed and described. After the extraction of a lens for the relief of myopia, a thirty-two year old artisan who was suffering from tabetic optic nerve atrophy, saw everything an emerald-green. After severe exhaustion, there would appear to him red points on a green field. Green-vision developed in a physician who had slept for a few hours in the full sunshine. Alter describes a case of green-vision (which he calls *monochromatopsia* for green) in a color-blind paralytic. In a tabetic, the field of vision appeared in green and violet spots, and the same condition was present with the eyes closed. One case of green-vision was observed as an aura in an abortive epileptic attack in a twelve-year old girl.

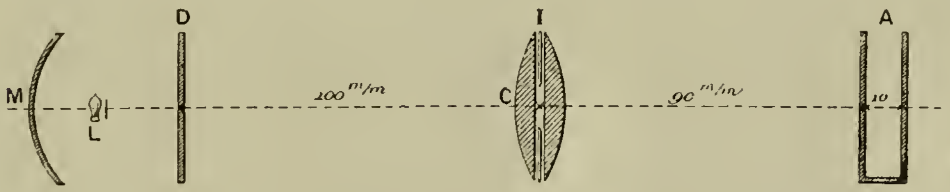
Black-vision. von Noorden has described a few cases of so-called black-vision, which occurred in chlorotic girls after fainting attacks. In these cases it would appear to be less a disturbance of the color-sense than a temporary amblyopia or amaurosis following a suddenly developing anemia of the brain, as so often happens in this class of patients.—(C. P. S.)

Chromatopsy. CHROMATOPSIA. A condition of the eye in which all objects appear in one particular color.

Chromatoptomer of Rose. A modification of Chibret's instrument. See **Chromatophotoptometer of Chibret.**

Chromatoptometer, Chibret's. See **Chromatophotoptometer of Chibret.**

Chromatoptomèter, Filtering. In this apparatus for measuring the relative intensities of color a standard lamp placed at the focus of a



Filtering Chromatoptometer.

concave mirror M illuminates the diffuser D. A biconvex lens of twenty dioptres, placed at a distance of ten centimetres from this diffuser forms an image of the same size at the same distance (ten centimetres). At this distance it strikes the anterior side of the tank A which contains the colored filtering solution. The lens L has a diaphragm; the opening of the diaphragm I indicates the luminous intensity of the colored image which forms upon the anterior surface of the tank. This intensity is directly proportionate to the surface of the opening of the diaphragm. If the lamp is standard, and if the composition of the filtering liquid is known and constant, one can express the chromatic sensibility by the inverse value of the surface of the diaphragm, which corresponds to the minimum coloration $S = \frac{1}{Cm}$. It is possible in a series of measurements to find the mean value of S for a particular color.

The filtering chromatoptometer does not, however, give conclusive proof as to the relative sensibility of the retina for the different colors, for the absorption produced by the filtering solutions is different for the different colors. The intensity of each color represents a part of the intensity of the lamp, which varies with each color. To determine the intensity of filtered colored lights it is necessary to compare them photometrically with a fixed standard.—(C. P. S.)

Chromatoptometer of Daae. See **Chromatoptometry.**

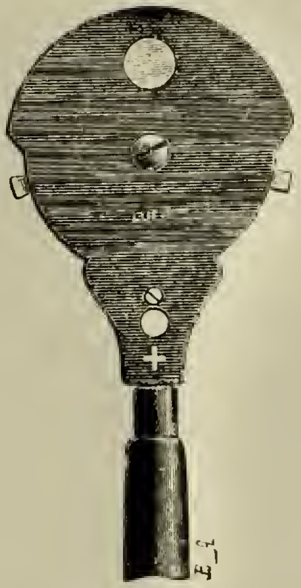
Chromatoptometric scale, Ole Bull's. See Vol. II, p. 1338 of this *Encyclopedia,* **Bull's (Ole) chromatoptometric scale.** This table, for the determination of acuteness of color-perception, comprises a great number of different colored but equal sized squares of equal brightness, but in diminishing degrees of saturation. At a distance of one metre the person to be examined *names the colors,* beginning with the lowest (the most distinct) row. This result must compare with the findings of a person with normal sight who, with good illumination on the squares, picks out the same colors in the highest (the most indistinct) row. See, also, **Color-sense and color-blindness.**

Chromatoptometry. Examination of the eye with reference to the degree of its sensibility to rays of light of various wave-lengths. The simplest method is that devised by Daae. The instrument consists of a cardboard containing ten horizontal rows of colors, each series being composed of seven colors, represented by woolen threads. In a certain number of series the colors are placed in the order of intensity. These rows correspond to the number 3 (purple), 7 (green), and 9 (red). The cardboard is placed before the patient in bright daylight, and he is caused to note that certain horizontal lines contain colors of the same tone, but of different shades. He is then asked if the colors of the first row are of the same kind, and the same question is asked him of all the rows on the cardboard. If he recognizes all the colors with their gradations, his color-perception is normal. If he distinguishes neither the lines which contain but one color nor the others, his color-perception is not completely determined, and the examination must be gone over again. If the patient indicates one of the series as containing but one color, when in reality it contains different colors, he is color-blind, and it then remains to determine, in any of the usual ways, the variety of color-blindness.—(Foster.)

Chromatoscope. An instrument with which it is possible to make three photographs give images at the same time on the same region of the retina. The three photographs represent the same object, but in one it is projected with red light, in another with green, and in the third with violet; and each picture in the instrument is lit with the same colored light. Accordingly one sees a picture in natural colors, since the component colors of the object, thus separated artificially, are again synthesized in the retina.

Chromatoscope, Ludicke's. An instrument for determining the refractive index of the colored rays of light.

Chromatoscope of Santos Ribeiro. This instrument for measuring the color-sense is pictured in the text.



Santos Ribeiro's Chromatoscope.

Chromatoscopy. The accurate determination of the color of objects.

Chromatoskiameter. Holmgren's apparatus for testing the color-sense, consisting of a lamp and a white porcelain screen; on the latter is projected the shadow of a pencil placed in front of different colored glasses. A scale shows when the shadows are of equal brightness.

Chromatoskiameter, Stilling's. An instrument constructed so as to produce colors in successive contrast. Used for the detection of colo blindness.

Chromatrope. Chromotrope. A term applied both to a kaleidoscopic lantern slide and a toy color-disc, which gives the effect of a stream of color flowing to or from its centre.

Chromeidoscope. A form of kaleidoscope having two mirrors placed at an angle of 70°. See **Anorthoscope,** Vol. I, page 503 of this *Encyclopedia.*

Chromesthesia. The association of colors with words, letters, and sounds.

Chromhidrosis. See **Chromidrosis.**

Chromhydrosis. Old form of **Chromidrosis.**

Chromidrosis. (L.) A condition in which the perspiration is colored. The phenomenon is sometimes limited to the eyelids, and the sweat is not uncommonly blackish or dark-blue; sometimes red, brown or yellow. The affection is generally found in neurasthenic and hysterical women; occasionally in malingerers.

Chromiometer. An appliance for estimating the optical purity of water.

Chromo-aberration test. See **Chromometer.**

Chromogen. Any vegetable or animal product capable of being changed into a colored substance or of acting as a color-producing body, even though it is itself devoid of color.

Chromogenic. Pertaining to chromogen. Color-producing.

Chromolume. An apparatus devised for the production of colored rays, and used for therapeutic purposes.

Chromometer. An instrument for measuring the intensity of colors. See **Chromatophotometer of Chibret.**

Chromometer, The Lorenz. A trade name for **Chromatic eye test (Lorenz).**

Chromophane. The coloring matter of the fat globules found in the cones of the retina in birds, described by Kühne.

Chromophilous cells of the retina. In their descriptions of the retinal ganglion-cells, Lenhossék and Dogiel recognize the presence of two distinct substances, a *chromophilous* readily staining, and an *achromatic* non-staining material. The disposition of the readily tinged constituent of the cell, as demonstrated after staining by Nissel's or Dogiel's modified methylene-blue method, varies greatly, the component granules being arranged singly, grouped, in rows, or as fibrillæ. According to the investigations of Max Schultze, both protoplasmic and axis-cylinder processes are composed of the same constituents,—namely chromophilous substance, ground-substance and fibrillæ,—only in varying quantities. The axis-cylinder process contains only an insignificant amount of the chromophilous and ground-substance, and consists principally of fibrillæ; in the protoplasmic processes, on the contrary, the fibrillæ are inconspicuous, while the staining material and the interstitial matrix are present in much larger quantities. See Norris and Oliver's *System of Diseases of the Eye*, Vol. I, page 312.—(C. P. S.)

Chromophose. A color phose, or subjective sensation of color. A phosphene.

Chromophotography. Photography in colors.

Chromopia. (L.) Chromatopsia. Colored vision.

Chromopseudopsis. (L.) Color-blindness.

Chromopsia. Chromopsy. A condition of the eye in which all objects appear of a particular color. See **Chromatopsia.**

Chromoptometer. A contrivance for determining the extent of development of color-vision.

Chromoptometer, Weber's. Apparatus invented by A. Weber for testing the acuity of the color sense. It consists of several series of colored papers so arranged that there is a series for each color increasing in size in a definite ratio—all fixed on a black background. The distance at which the color of each piece of paper can be distinguished is the index of the acuity of color perception.

Chromoptometry. See **Chromatoptometry.**

Chromoscope. An apparatus for testing the refractive indices of colored lights.

Chromosphere. In astronomy, the red-colored envelope of the sun, outside of the photosphere.

Chromostroboscope. A device for showing the persistence of visual impressions of color. See **Anorthoscope.**

Chromsäure. (G.) Chromic acid; chromium trioxide.

Chronophotometrie. (G.) This is a method of subjective photometry suggested by Stigler, and fully described by him (*Zeitschr. f. Sinnesphysiol.*, Vol. 44, pp. 62 and 116).

Chronoscope. An instrument contrived by Sir Charles Wheatstone to measure the duration of certain short-lived luminous phenomena, such as the velocity of light, or the electric spark. The phenomenon is observed by reflection in a mirror in such rapid motion that the image of the luminous object appears to describe a circular arc the length of which must be a measure of the duration of the light. The electric spark is found by this test to have no measurable duration, because its image in the mirror is a mere point. By means of it Foucault compared the velocities of light in air and in water.

Chroopsia. (L.) A synonym of chromatopsia.

Chroopsy. Chromatic vision.

Chrotopsia. (L.) A synonym of chromatopsia.

Chrupsy. Chromatic vision.

Chrysaniline dinitrate. This anilin derivative is sometimes given for nervous affections in small doses. When administered in larger quantities it produces mydriasis, accompanied by diminution of arterial pressure.

Chrysarobin. J. Igersheimer (*Klin. Monatsbl. f. Augenheilk.*, 1912, No. 5, page 518) and P. Cohn (*Wochschr. f. Therapie u. Hygiene d. Auges*, 1912, No. 43, page 353) discuss so-called "chrysarobin conjunctivitis." Igersheimer does not consider the designation of this eye disease to be altogether apt, as the conjunctiva is only inflamed and swollen in the mildest cases, while in the majority of cases the cornea is also severely affected. It will therefore be better in future to use the term "chrysarobin keratitis." Cohn also describes a typical case of keratitis of this kind. The patient had been treated with chrysarobin for psoriasis. The eye-lids were greatly swollen, the conjunctiva inflamed, and the cornea, in the presence of epiphora and marked photophobia, showed distinct epithelial opacity. On discontinuing the administration of chrysarobin the symptoms of disease immediately improved and a cure followed. If in these cases treatment by chrysarobin is continued, the corneal epithelium becomes detached in the form of little vesicles, groove-like opacities occur and ulcers may even form. Igersheimer also quotes similar cases observed by Linde, Lewin and Guillery, and refers to the work of Loewenson and Krause on this subject. As in the case reported by Cohn, chrysarobin keratitis usually appears to be due to the careless or unintentional introduction of chrysarobin directly into the eyes. The disease has not, at any rate, been shown to be caused by the absorption of chrysarobin. In one case, however, Igersheimer assumes that this occurred. Treatment is limited to the discontinuance of the application of chrysarobin and the employment of boric acid. (Merck's *Reports*, 1912.)

The affections of the eyes due to the action of chrysarobin, so far published, have been primary catarrhal inflammations of the conjunctiva, eventually secondary changes in the cornea. This is corroborated by an observation of Krause. In two other cases, however, the keratitis was primary. In one case it consisted in a ring-shaped opacity of the parenchyma, resembling the annular, central, vascular, parenchymatous keratitis but of more acute character. The opacities in the third case formed furrows in radial arrangement, and were similar to herpes. Whether these affections are characteristic of the action of chrysarobin, can only be decided by observations on a larger amount of material. See **Acid, Chrysophanic.**

Chrysitis spodos. (L.) The "ashes of spuma auri" (the dross left after dissolving gold), recommended in ancient times for ophthalmia.

Chrysops aveuglant. (F.) Chrysops cæcutiens (q. v.).

Chrysops cæcutiens. (L.) A species of gad fly which attacks man and the larger animals in the region of the eyes, inflicting painful bites, and making them blind.

Chrysun. (L.) An ancient collyrium prescribed by Ætius.

Chthononosology. The science of the geographical distribution of diseases.

Churchill's tincture. See **Iodine.**

Chute de la paupière. (F.) Blepharoptosis, or falling of the upper lid.

Chute des cheveux. (F.) Falling of the hair.

Chymosine. (F.) Pepsin.

Cibisitome. An instrument devised by Petit-Radel for lacerating the anterior capsule as a step preparatory to the extraction of cataract.

Cicatrice della cornea. (It.) Corneal scar.

Cicatricial entropion. This affection is almost invariably caused by trachoma, but it may follow wounds, essential shrinking of the conjunctiva, burns and deep-seated forms of conjunctivitis. The cicatricial form of entropion is the result of distortion of the tarsal plate by the contraction of cicatricial tissue that has formed in it and in the conjunctiva covering it. Such cicatrization is usually the result of long continued trachoma; or it may follow burns, pemphigus or diphtheria of the eyelids or conjunctiva.

The contraction of the scar tissue "buckles" the tarsus so that its under surface is much more concave than normal, and in chronic cases of trachoma presents a distinct furrow parallel to the free border. Corresponding to this furrow there may be on the anterior surface of the tarsus a distinct ridge. Because of the bowing inwards of the tarsus the posterior margin of the free border is pressed against the cornea and by constant attrition is rounded or beveled. As a result of the continued irritation of the cornea by the border of the lids, and it may be by the cilia, a certain degree of blepharospasm is excited which aggravates the trouble by adding the spastic to the cicatricial form. In the severest forms the lid may be so incurved that the lashes rest on the eyeball, as they do in typical cases of trichiasis or spastic entropion.

It will be seen that in trichiasis there is no distortion of the lid plate, except possibly around the hair follicles on the free border and, therefore, no real entropion, while in cicatricial entropion there may be trichiasis in addition to the deformity of the tarsus. In deciding upon the operative treatment of trichiasis and entropion, these various features should be borne in mind, and the operation must be varied to suit the individual case. If the spastic feature predominates, this must receive especial attention, while if trichiasis is the marked feature, without the more severe cicatricial entropion, certain other operations will be applicable.—(W. H. W.)

For the treatment of this condition see **Entropion** and **Trichiasis.**

Cicatricial orbit. As the result mainly of deep burns other injuries and operative procedures one or both cul-de-sacs may be obliterated, in part or entirely. In this case it is impossible to wear a perfectly fitting artificial eye and various operations are performed to obviate the difficulty. The most important of these are fully described in Volume II, page 1107, of this *Encyclopedia.*

Cicatricial pterygium. Pseudopterygium. This term is applied to the fixation of a fold of conjunctiva upon the cornea as a sequence of inflammatory action. It may result from trauma by heat or caustics, or may follow operations for the removal of conjunctival growths. In some instances pseudopterygia develop after chronic superficial ulceration of the margin of the cornea. In other cases they are sequent to a chronic blennorrheic or to a diphtheritic process. A true pterygium ordinarily permits the passage of a sound beneath its folds at the limbus, while in pseudopterygium this cannot be done. In the former the growth generally is progressive, while pseudopterygia remain fixed at the part of the cornea to which they originally became attached. Small pseudopterygia may be permitted to remain; large ones should be excised. There is a rare form of false pterygium named pterygo-symblepharon, which is characterized by adhesion between the lower lid and the cornea through an intervening flat, vascular band of conjunctiva.—(J. M. B.)

Cicatricial trachoma. This is, according to Knapp, the "end stage" of uncured cases, while MacCallan believes it to be nature's final effort to cure an inveterate infection of the conjunctiva.

Cicatricule. (F.) A small cicatrix.

Cicatrisotomy. Exsection of a scar-tissue mass.

Cicatrix, Bulging. Especially after cataract extractions and in connection with other penetrating wounds of the eyeball we may encounter, instead of a smooth healing scar, one that bulges at some portion of the wound. Sometimes this bulging involves the whole of the cicatrix, but in either case it forms a well-rounded, semi-transparent elevation in which the iris is generally entangled. See **Bulging cicatrix.**

Cicatrix, Filtering. De Wecker long ago maintained that it was not the removal of the iris which diminished the intraocular tension in glaucoma, but rather the formation of the "filtering cicatrix." In recent years this theory has gained many adherents and ophthalmological journals have contained a remarkable number of diverse methods to obtain filtration areas. While there are still those who believe that a soundly healed cicatrix possesses filtration properties, the majority of observers, perhaps, have now arrived at the conclusion that such is not the case, and consider that a firmly healed cicatrix in the sclera is no more permeable than normal tissue. The newer procedures, therefore, aim at the removal of some of the sclera, in the hope that the remaining parts, even after healing, will be permanently less resistent, and will thus allow the intraocular fluids to pass more rapidly from the eye.

One of the chief opponents of the theory of filtering cicatrices is Henderson, who contends that the success of the operative procedure in glaucoma does not result from the particular method of incision adopted, but depends, as has been well shown clinically since Graefe's time, on the iridectomy and on the state of the iris. He bases this statement upon anatomical investigations which demonstrate in his opinion that, while corneal incisions heal and cicatrize, the cut iris surface forming the base and pillars of the coloboma, never does, but always remains as when first severed, thus acting as a drainage area, the efficacy of which depends on the condition of the iris at the time of operation. Thomson and Grimsdale give an impartial review of the question of the so-called filtering cicatrix. Very recently, also, Ballantyne has contributed an extremely valuable paper upon the same subject, and has given a most lucid review of all the newer operations for glaucoma.—(W. C. P.) See **Glaucoma.**

Cicatrization. The process of healing or skinning over of an ulcer or broken surface in the skin or mucous membrane, by which a fibrous material of a dense resisting character, covered by a protecting layer of epithelium, is substituted for the lost tissues. The new tissue in such a case is called a cicatrix, and usually resembles to a considerable extent the structure which it replaces; it is, however, less elastic, and from its shrinking in volume may produce an appearance of puckering. This shrinking sometimes leads to serious results, especially after extensive burns. In July, 1911, Carrel, head of the Rockefeller Institute, announced to the Pasteur Institute that he had been able to keep alive and cultivate animal tissues cut from the body and actually to study the healing of those tissues under the microscope. His observations should be of great value in the remedial relations of cicatrization. *(Standard Encyclopedia.)*

Cichorien-Kaffee. (G.) Chicory coffee.

Ciclite. (It.) Cyclitis.

Cicutine. Another name for coniine.

Cicutine. See **Coniine.**

Cidre. (F.) Cider.

Cieco. (It.), adj. Blind.

Cigar amblyopia. There is nothing distinctive about the form of the toxic amblyopia from cigars. In estimating the probable effect of the tobacco thus used in a given case Cohn (*Centralbl. f. pkt. Augenheilk.*, 1879, p. 300) very properly insists that we ought to consider not only the kind but the weight of cigars when tobacco is used in that form. He quotes a case of nicotine amblyopia where in the early stage of the disease the patient smoked first Havanas and later the same number of Dutch cigars. As a rule, Cuban cigars contain 2.02 per cent. and the Dutch 1.8 per cent. of nicotine, but as the former weighed only 4.7 grms. and the Dutch 9 grms., the latter are more likely to be responsible for the disease.

Cigarettes. Although cigarette smoking is universally condemned and there can be no doubt that its effects on the system (mostly due to inhalation of the smoke) is deleterious, especially to the young, yet eye symptoms (tobacco amblyopia) are rather uncommon. As the Editor noted many years ago (*The Toxic Amblyopias,* 1892-1894), in Turkey, where cigarette smoking is almost the only form in which the weed is used, by both sexes and among all classes, tobacco amblyopia is, according to Van Milligen (*Trans. Oph. Soc. U. K.*, Vol. VIII, p. 242), Hübsch (Quoted by Albutt, *''On the Ophthalmoscope,''* p. 262), and other competent observers, almost unknown; yet the annual consumption of tobacco by the Turks is enormous. Van Milligen says that for many years the ''nargileh'' and pipe have been quite out of fashion. The smoke from the (Turkish) cigarette tobacco (containing 3 to 4 per cent. of nicotine) is drawn into the lungs, but the mouth end of the cigarette is so prepared that none of the tobacco touches the lips; consequently no nicotine is directly absorbed.

Cigar tree. See **Catalpa.**

Ciglii. (It.) The eyelashes.

Cil. (F.) A cilium or eyelash.

Cilia (plural of cilium). The eyelashes; this term was also formerly used to designate the free margins of the lids.

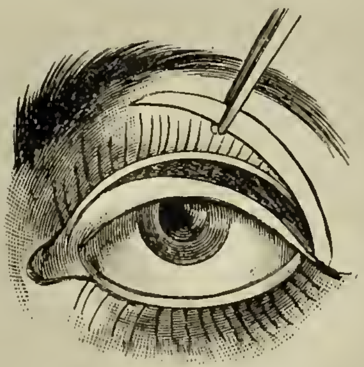
The eyelashes are well-developed hairs of various colors, arranged in two and sometimes three rows at the palpebro-conjunctival junction.

The cilia of the upper lid are longer and more numerous than in the lower. In the former situation they number from 90 to 150, while in the lower lid from 40 to 80 are generally seen. The hairs curve in opposite directions in the lids, so as to present their convex curves to one another. The eyelashes are of different ages and exhibit different stages of growth. They are constantly falling out in a perfectly normal fashion—the life period of each cilium being about four months.

The cilia develop exactly as do hairs elsewhere in the body. The first appearance of the hair is represented by an elongation of the nuclei of the deep columnar epithelium and its gradual growth into the depths away from the corium. From this hair-germ develop the hair papilla and eventually the hair itself, with the accompanying sebaceous gland. The earliest reported primordial cells of the cilia were in an embryo 27 mm. in length and were very few in number, compared with the hair-germs in the eyebrow and lip region.—(H. S. G.) See, also, **Eyelashes.**

Also, hairlike processes borne by some cells. They are mobile modifications of the living matter of the cell, and exhibit alternate bending and straightening. Their occurrence is very wide—e. g., in the active stages of many unicellular plants; in great perfection on the ciliated infusorians; on the free-swimming embryos of sponges, cœlenterates, worms, echinoderms, and molluscs; on the outer surface of many lower animals such as simple worms; on the lining of the alimentary cavity, and in most of the tubular organs of invertebrates; and more restrictedly, though not less markedly, in some regions (such as trachea) of higher forms. In many cases, normal, pathological, and artificial cilia may sink down into less motile ameboid processes. *(Standard Encyclopedia.)*

Cilia, Gayet's transplantation of. The idea that the hair bulbs of the eyelashes can be transplanted was first suggested by Jaesehe (*Prager Medicin. Wochenschr.*, 1845, Vol. 7), but, probably, the best known pro-



Gayet's Operation for the Transplantation of Cilia. (After Harlan.)

cedure for the purpose is that of Gayet (*Annales d'Oculist.*, 1882, No. 1, p. 27). Gayet suggested that a strip of skin removed from the eye, as in the Alt operation for trichiasis (see page 589 of this *Encyclopedia*) be left attached at the extremity of the wound towards the outer canthus and to be then transplanted in the groove formed by splitting the lid-margin. This wound is made sufficiently deep so that it will gape about 4 mm., then a flap corresponding to the size of the wound is formed from the lid just above the margin of the latter.

In the accompanying figure this strip of skin is shown dissected up and held by the forceps ready to be transplanted to its new situation. It is there secured by two sutures, one entered at the free extremity and the other at the base.

Cilia in the anterior chamber. Cilia which enter the eye by traumatism are generally tolerated for years without causing the least symptom. They may, however, give rise to infection, or, more or less early, to irritation, ciliary injection, photophobia, lacrymation, pain, or to the development of epidermoidal tumors of the iris, cysts or margaritomas, with subsequent glaucoma, blindness or loss of the eye. Therefore their early removal is indicated, although even then tumors may develop from epidermoidal particles simultaneously introduced.

Paderstein (*Centrabl. f. pkt. Augenheilk.*, Jan., 1910) reports the following case: A piece of iron flew against the left eye of a laborer, perforating the cornea, with incarceration of iris, perforation of the anterior capsule and circumscribed opacity of the lens. The sideroscope showed that there was no iron in the interior, but there was a cilium with its root lying on the portion of iris which extended to the anterior synechia. An attempt to remove it after five weeks with a pair of forceps through a section at the inner margin failed on account of prolapsing iris tissue, but succeeded with the blunt iris hook, followed by speedy recovery.

Four weeks later another cilium was seen near the pupillary margin. An attempt to extract it was frustrated by a hemorrhage from the iris. The hemorrhage was absorbed within a few days, but the whole lens became opaque and lens matter projected into the anterior chamber. After three weeks the cilium, probably having wandered about, appeared again at its former site.

A case of cilium in the anterior chamber, occurring in a man who had been injured in the eye, twelve years previously, by a splinter of wood, is reported by Barr (*Jour. Ophthal. and Oto-Laryng.*, Sept., 1909). Two weeks before the case came under the observation of the author the patient received a blow on the head and this was immediately followed by a mild iridocyclitis. Examination showed that there had been absorption of the lens from the original injury, with a partial posterior synechia. There was a small leucoma in the center of the cornea from the posterior surface of which a cilium extended backwards to the lens capsule. A corneal incision was made and the cilium removed.

The author calls attention to the duration of the foreign body in the anterior chamber without causing irritation and believes that from the time of the original injury to the time of the blow on the head both ends of the cilium were attached and that the force of the blow dislodged the corneal attachment, thus causing irritation and an iridocyclitis.

It must not be forgotten that when eyelashes are by any means carried into the anterior chamber the epithelium about the root-sheath may become implanted and give rise to pearl cysts of the iris. As is well known, Mackenzie first reported a case of this kind and noted its traumatic origin. Rothmund (*Klin. Monatsbl. f. Augenheilk.,* Vol. 10), in 1872, collected histories of 36 cases of this order, in 3 of which an eyelash could be readily distinguished within the cyst-wall.

Another example of cilium in the anterior chamber is described by Rubbrecht (*Klin. Monatsbl. f. Augenheilk.,* Jan., 1911, p. 114).

Cilia, Microbiology of the. Fava (*Annales d'Oculist.,* August, 1908) examined for microörganisms the roots, the middle portions and the ends of the cilia. The microbes found belonged, for the most part, to the aërobic class and only exceptionally to anaërobic. In tubes planted with cilia before disinfection of the lid margin, fifty colonies were obtained from the roots, thirty from the middle parts, and fifteen from the extremities. Cultures made with cilia taken after disinfection were sterile. In cases of blepharitis there was an average of ninety cultures for each tube. Among the aërobic microbes the staphylococcus albus was found frequently, but the author doubts if it plays a part in the etiology of affections of the ciliary border. The bacillus subtilis was found once in the root, three times in the middle part, and four times in the end. Of the two anaërobes isolated, one came from the root and one from the end of the cilium. The saprophytic microbes most frequently met with are capable of causing grave inflammatory symptoms of the globe when inoculated in the posterior chamber of the eyes of animals. The parasite most frequently met with is the demodex folliculorum of Simon, which is found in the root of the cilium. It has no pathogenic power, but may act as a foreign body in dilating the ciliary follicle and thus favoring the entrance of microbes. (See, also, page 1022 of this *Encyclopedia.*)

Cilia, Misplaced. TRICHIASIS. DISTICHIASIS. This is a condition of the lid in which some or all of the cilia are distorted, displaced and turned inward toward the eyeball. Normally, the cilia are arranged in several rows on the anterior margin of the free border of the lid, those of the upper lid curving forward and upward, those of the lower lid projecting forward and downward. With partial closure of the eyelids there is a certain amount of interlacing of the eyelashes that furnishes a degree of protection to the eyeball from dust and wind.

In the milder forms of trichiasis, the posterior row of the cilia is turned backward, so that some or all of the hairs may come into contact with the eyeball. In the severer forms of the disease the anterior rows may also be directed downward or even backward, so that all of the lashes may rest against the eyeball. The cilia are usually changed in appearance, are stunted and stubby, and may grow straight out from the free border of the lid. Some of them may be so fine as to be scarcely visible to the unaided eye.

These changes are brought about by diseases or injuries that affect the border of the lid or the conjunctiva, and so alter the nature and direction of the hair follicles. Consequently we frequently see this condition after trachoma, blepharitis, burns of the edge of the lids and diphtheria; while the partial forms are noticed after hordeolum, chalazion and abscesses of the lids.

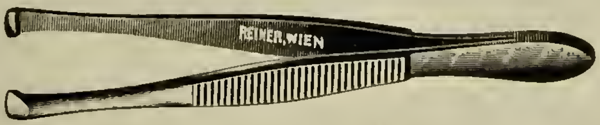
Trichiasis, aside from the disfigurement and discomfort that it produces, may be exceedingly serious, for the rubbing of the eyelashes against the cornea may occasion pannus, as well as opacities or ulceration of that structure.

Distichiasis is the term used for the condition in which there is a double row of eyelashes, the anterior of which may be directed normally, while the posterior is directed downward and backward from the free border of the upper lid. Naturally this is only a variety or degree of trichiasis, if it is acquired, and inasmuch as there is a congenital condition in which the cilia grow in two rows as described, the term distichiasis should be reserved for it.

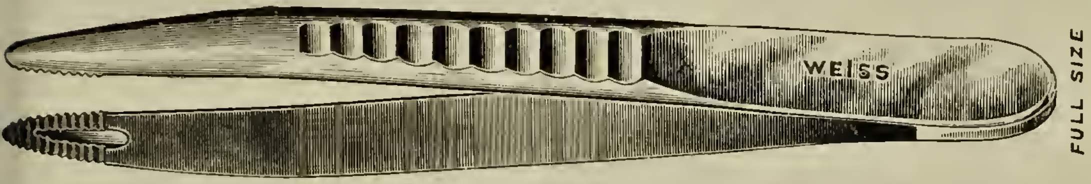
Entropion is an exaggerated degree of trichiasis with this difference, that whereas in trichiasis the free border of the lids remains in its normal position, in entropion the free border is turned inward toward the eyeball.

When trichiasis is limited to a small part of the lid, or when a few of the cilia are misplaced and, turning inward, irritate the eyeball, they should be removed either by epilation or, better, by electrolysis. The misplaced hairs are sometimes so fine and so light colored that a careful search with good illumination and the aid of a lens is necessary to discover them. If epilation is practised the hair is seized near its base with cilia forceps and gently drawn (not jerked) in the direction of the shaft.

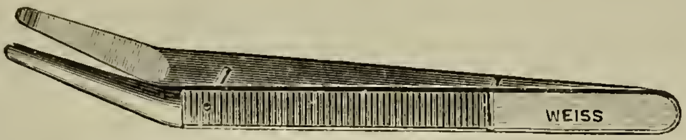
Cilia forceps such as manufactured by most instrument makers are ordinarily very imperfect, and many of them are quite useless for the purpose for which they are intended. The opposing surfaces at the ends of the blades should come into perfect apposition, otherwise fine hairs will not be caught. In selecting such an instrument one should subject it to the test of holding it up to a light with the blades closed, and noting whether any light can be seen between the apposed surfaces at the ends of the blades. Too frequently it will be found that the surfaces come into actual contact at one small point only.



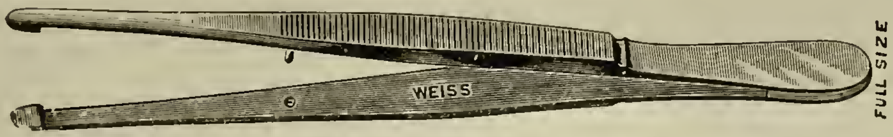
Common Form of Cilia Forceps.



Bader's Cilia Forcep's.



Duckworth's Cilia Forceps.



Straight Cilia Forceps.

Even after proper epilation, however, it is only a matter of time until the hairs grow again, so that it is much better to destroy the hair follicles by means of electrolysis.

Electrolytic epilation. It is best to place the patient in a recumbent posture and in a good light; oblique illumination should be used if the light is artificial. The operaton is rather painful, so that if a number of hairs are to be removed at one treatment it is best to inject into the edge of the lid a drop or two of a 1 per cent. cocaine solution, in addition to cocainizing the conjunctiva. This will make less painful the application of some kind of lid clamp, or the lid spatula of Jaeger, which will be useful to give good support to the lid.

A very fine needle, or a fine drill such as is used by jewelers, is mounted in a suitable handle that can be connected with the negative pole of a galvanic battery, which should be provided with a rheostat and a galvanometer. A wet sponge electrode connected with the positive pole is applied to the neck or cheek of the patient. If the operator is in doubt as to the polarity of the current he can easily determine it by immersing two metallic electrodes in a glass of water, and noting that when the current is turned on, a greater number of bubbles of gas (hydrogen) accumulate around the negative pole, than around the positive (oxygen).

The operator should use a binocular loupe (such as Jackson's or Berger's) in order to pass the needle accurately along the shaft of the hair into its follicle. When the needle has been thus passed into the follicle to a depth of 2mm. to 3mm. and the sponge electrode has been applied to the cheek, the current is turned on and controlled by the rheostat until the galvanometer shows a current of 0.5 to 1 milliampere. Electrolytic action is shown by the bubbles of gas that accumulate around the needle and hair shaft. When this has been continued for nearly half a minute, the current is gently turned off and the needle withdrawn. The dead hair can then be easily extracted with the cilia forceps. If any resistance is encountered in extracting it, it is evidence that the electrolysis around the hair root is not complete, either because the current was not applied long enough or, more probably, because the needle was not accurately placed in the follicle. Considerable care is necessary in thus epilating the very fine hairs that are so frequently the cause of great annoyance, but the result amply repays the effort.

Complete removal of the cilia border in trichiasis. The operation of "scalping the lids" is one that is now rarely performed, although in extremely obstinate cases it may be practised. Naturally, it is more to be avoided on the upper than the lower lid, for the lashes of the upper lid are more essential to protection of the eye than those of the lower. It was probably suggested by the practice of the ancients of completely destroying the hair follicles by a hot iron. The method that is usually followed is that suggested by Flarer (*Riflessioni sulla trichiasi, Milan,* 1828).

Flarer's operation. Either a horn plate, such as Jaeger's lid spatula, or a broad lid-clamp is placed beneath the lid, to hold it firmly and give support. With either a keratome or a narrow scalpel, such as a Graefe cataract knife, an incision is made along the whole length of the free border of the lid, splitting it into two layers. In making this incision the gray line is followed that lies between the openings of the Meibomian glands and the row of cilia. In cases where the posterior margin is rounded off, and the row of cilia is more or less distorted, this grey line is not well defined, and then the operator in making this intermarginal incision must take care that all the cilia lie in front of it. The incision thus passes into the loose connective tissue that separates the orbicularis from the tarsus, and should extend in depth about 3 mm., or beyond the depth of the hair follicles.

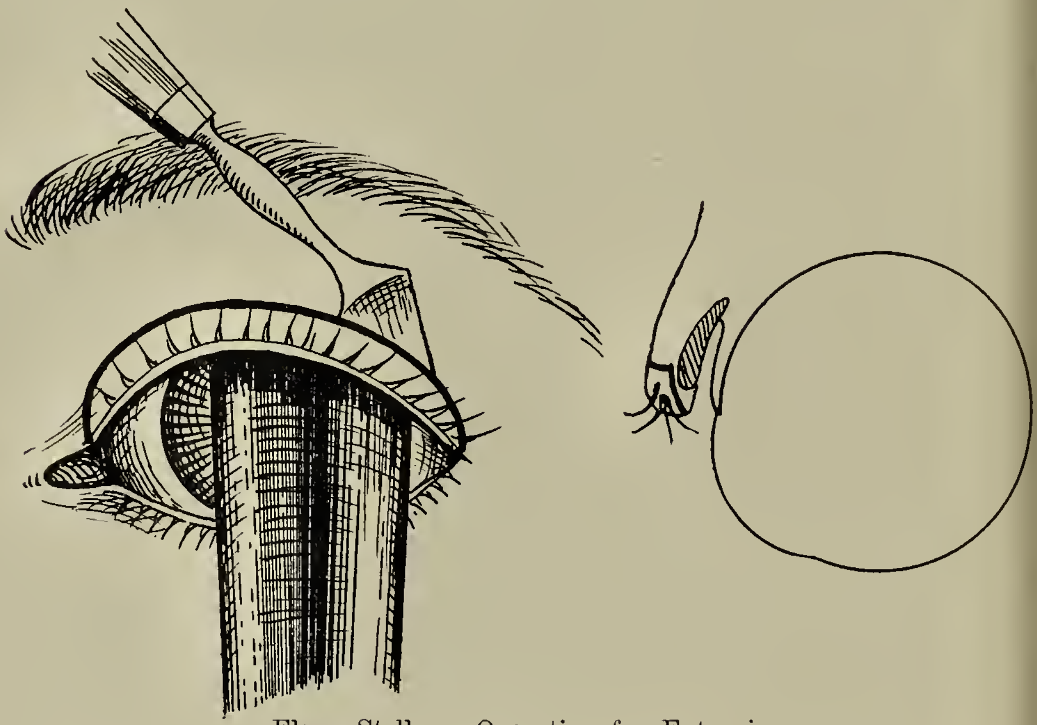
An incision is then made in the skin, parallel to and about 3 mm. from the free border, and at each extremity of this another curved cut is made meeting the ends of the intermarginal incision. This strip, containing the cilia, is easily dissected off. Care should be taken that all the roots of the hairs are removed. Any black points that remain should be dissected out with scissors. The raw surface, which heals by granulation in a few days, may be covered with a moist boric acid dressing.

The disadvantages of this method are obvious. It causes an unsightly appearance, removes structures important for the protection of the eyeball and in cases where entropion is a marked feature leaves a harsh scar at the lid border that often irritates the eyeball as much as did the hairs. It has received an important modification by Stellwag, which is applicable to cases in which trichiasis, rather than entropion, is the dominant feature of the case.

Flarer-Stellwag (*Allegemeine Wiener Med. Zeit'g.*, 1883, No. 49) *operation for trichiasis.* The operation (see the illustration) is performed in every respect like the one just described, with this addition. After the strip of tissue bearing the cilia has been removed, it is placed in warm normal-salt solution (0.5 per cent) until the bleeding of the raw surface at the edge of the lid is checked. The narrow flap is then placed in a reversed position on the raw surface (i. e., what was the temporal end of the strip is placed at the nasal end of the denuded area), and is gently fitted into position. A very fine stitch at either end may or may not be necessary. The little flap is sprinkled thickly with iodoform powder, and the wound is then covered with rubber tissue, or silk protective, that has been smeared over with vaseline. Over this the dressing is placed. Both eyes should be bandaged for two days to prevent, as far as possible, movement of the lids. The dressing may be changed every day after this. The lashes in the strip usually fall out, but if the flap is retained as it usually is, the lid border although bald, does not present the disfiguring and irritating scar surface that it would after the scalping process.

Naturally, this method is more applicable to cases in which the whole row of eyelashes is symmetrically turned inward than in those where the hairs are straggling, some of them pointing inwards and many of them outwards.

Although this operation should, according to the plan outlined, be considered under treatment of the free border of the lid by processes of grafting, it was thought best to present it here as a modification of the ablation operation, and as naturally leading up to a study of the procedures described in the following division.



Flarer-Stellwag Operation for Entropion.

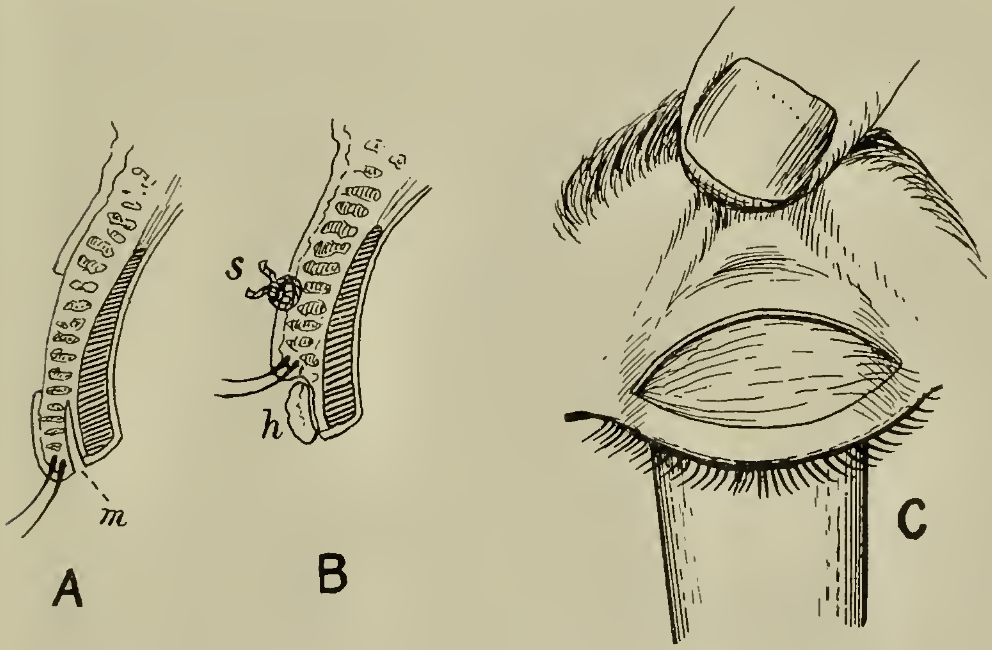
The cilia border is removed by splitting the lid margin along the gray line, and then making an incision 3 mm. from the free border. The flap thus excised is then reversed.

Correction of faulty positions of the cilia by displacement of the cilia border. Operations of this group attempt to displace or transplant the cilia border in such a way that the lashes will not come in contact with the eyeball.

Attempts to correct trichiasis in this manner were probably made by the older physicians, and it is said that the operation, presently to be described as that of Jaesche-Arlt, is identical with the one described by Paulus Ægineta in the seventh century.

In most of the operations of this class, in addition to transplanting the cilia-bearing zone away from the free border of the lid, there is introduced the plastic feature of covering the denuded area with skin or mucous membrane, in the attempt to prevent as far as possible the formation of scar tissue on the free border.

Operation of Jaesche-Arlt (*Med. Zeitung Russlands,* 1884, No. 9, and Graefe-Saemisch *Handbuch d. grs. Augenh.;* 1st Ed., Vol. III, p. 447). An intermarginal incision, similar to that described in the Flarer method is made along the whole length of the lid, following the gray line on the free border. This incision should be 3 or 4 mm. in depth, and should be so placed that all the lashes will be in the anterior layer which is separated from the tarsus. A fold of skin is next removed from the anterior surface of the lid in the following manner: An incision is made in the skin parallel to the free border and about 4 mm. from it; above this and joining it at each end, there is made a curved incision through the skin, which marks out a crescentic area of skin that at its widest part at the middle of the lid is about 8 mm. This crescentic piece of skin is then dissected off with blunt-pointed scissors or scalpel, care being taken not to buttonhole it, and not to remove the



Transplantation of the Bed of Hair Follicles by the Method of Jaesche-Arlt.

A. Cutaneous incision and incision in the intermarginal line, *m;* B. After tying the cutaneous sutures, *s,* and implanting the piece of skin, *h;* C. Front view after excision of the skin has been done, with the horn plate inserted.

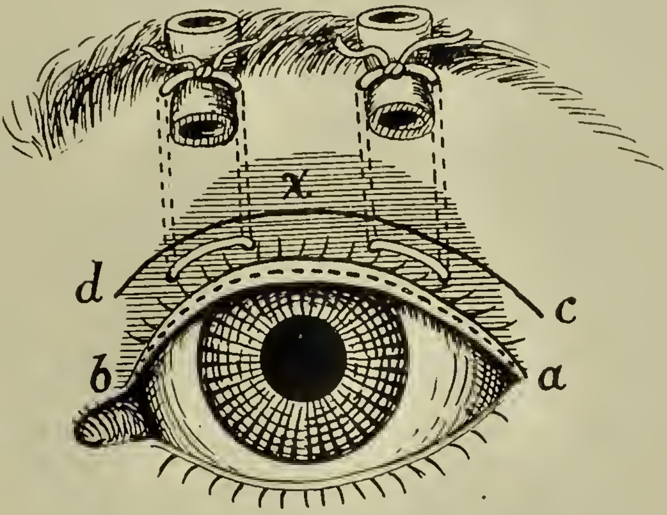
subjacent fibers. The gap produced by the excision of this piece of skin is then closed by five or six sutures. Arlt recommends that, in placing them, the needle first pass through the skin of the upper edge of the cilia flap, then include some of the orbicularis fibers over the tarsus and, finally, the skin of the upper lip of the wound. The sutures are not cut off, but are drawn upwards to cause the cilia border to take its new position higher up on the tarsus, and are secured to the forehead over the brow by an adhesive strip. The raw surface below the cilia border is allowed to heal by granulation. This objectionable feature is overcome by the plastic modification suggested by Waldhauer (*Klin. Monatsbl. f. Augenh.,* 1883, XXI, p. 432) of placing the excised strip of skin on the raw border, and the operation is usually practised now with this valuable modification. After excising the strip of skin, which should be as thin as possible, it is placed in warm 0.5 per cent. NaCl solution until the wound in the skin has been closed, as described, and the bleeding at the border of the lid has been completely checked. It can then be placed in position on the raw border of the lid, and if necessary trimmed a little, to make it fit exactly. This trimming should be done with scissors, only after the flap is in position and held by an assistant. In most cases sutures are unnecessary, but possibly a fine one may be placed at each end and one in the middle, if the flap is not nicely apposed.

Care should be taken not to excise too wide a piece of skin lest ectropion result. To avoid this, before making the skin incision, the operator should estimate the amount required by pinching up a fold of skin and noting the effect on the lid border.

As in all cases of transplantation of skin flaps, strips of rubber tissue or oiled silk should be placed over the wounds before applying the dressing. The wound should be dressed each day, and at the end of the second day traction on the sutures may be released. The wound should have healed sufficiently by the fourth or fifth day to allow the removal of the sutures. Should the flap slough, it will be necessary to cover the granulating area with a piece of hairless skin taken from behind the ear, or with a piece of mucous membrane from the inner surface of the lip.

Indications for the Jaesche-Arlt operation. This operation, with the important modification of Waldhauer, may be practised either upon the upper or lower lid. It is more applicable in cases of partial or complete trichiasis in which there is no marked distortion or incurving of the tarsus. It has no power to correct the latter condition, because the sutures have no fixed point of support, and in such cases one must have recourse to some tarso-plastic operation.

Graefe (*Archiv. f. Ophthal.* Vol. X, 2, p. 221), observing that the misplaced cilia at the extremities of the lid were not controlled by this method, modified it in the following manner. At each end of the intermarginal incision vertical incisions were made through skin and muscle, so that the whole cilia border could slide upward. There was then excised from the upper lid an oval piece of skin of such a size that the closure of the resulting gap would draw up the detached lid border, or loop sutures were placed and tied over rolls, to remain a few days until the lid border had become fixed in its position. The new border was then allowed to heal by granulation.



Landolt's Operation for Trichiasis.

The Lid is split along the border shown by the dotted line, *a*, *b*, and all the tissues separated from the tarsus up to or above its superior border, indicated in the cut by the shaded portion. An incision, *c*, *d*, is then made 3 mm. from the lid border, and this bridge of tissue, *a*, *b*, *c*, *d*, containing the cilia, is drawn up under the upper flap, *x*, by loop sutures, as shown in the figure. The lower edge of the flap, *x*, then comes down to form the border of the lid.

De Wecker (*Klin. Monatsbl. f. Augenh.*, 1879, p. 141) recommended, as a modification of the Jaesche-Arlt method, making first a canthoplasty; then, after an intermarginal incision, holding back the detached cilia border by the application of 3 or 4 Gaillard sutures. He allowed the border to granulate. The procedure of Bauchon (*Annales d'Oculistique,* 1879, Vol. 81) was very similar to that of de Wecker.

Landolt's operation for the relief of trichiasis. Landolt (*Arch. d'Ophtal.,* Vol. X, 1890, p. 1) changed the position of the cilia in the following rather complicated and ingenious manner. The margin of the lid was split along the gray line, as in the Jaesche-Arlt method, but the incision was made much deeper, so that all the tissues were separated from the anterior face of the tarsus. This dissection of the lid into two layers is done with scalpel and scissors. An incision (Figure) is then made from one angle of the lid to the other, parallel to and about 3 mm. from the lid border, through the anterior layer to the tarsus. There is thus formed a bridge of tissue that includes the cilia border.

The eyelashes are then cut off quite short, and this bridge of tissue is made to glide under the upper flap, which has been undermined, by means of two loop sutures which, placed at proper places in the bridge flap, pass under the upper flap and the skin and emerge from the skin at the eyebrow. Enough traction is made on these sutures to bury completely the cilia border under the upper flap, the lower edge of which comes down by its own weight, aided by a little traction, to form the border of the lid. The sutures are tied around a roll of gauze. After healing has taken place, and the bridge is attached in its new position to the tarsus, the sutures are removed. Another operation is done later, to liberate the eyelashes. This procedure consists in making an incision about 1 mm. from the new palpebral border, parallel to it, through which the cilia may escape.

Oettingen (*Dorpater Med. Zeitschr.,* 1871, Vol. XI, Pt. 1, p. 45), through a deep intermarginal incision, separated the anterior layer of the lid from the tarsus up to its superior border, so that the cilia zone could be drawn upward and fixed to a new position on the tarsus by means of sutures which were passed through the skin near the lashes and into the tarsus near its superior border.

The operation of Kostomiris was done in much the same manner.—(W. H. W.) See, also, **Entropion,** as well as **Distichiasis** and **Trichiasis.**

Cilia, Operations for removal of. See **Cilia, Misplaced.**

Cilia, Poliosis of the. Premature bleaching or whitening of the eyelashes. An account of this rather rare affection is furnished by Vogt (*Tydsch. van Geneesk.,* Feb. 24, 1906). In one instance, a youth, aged 18, had iridocyclitis of both eyes for nine weeks (the affection had commenced five weeks previously) showing a marked white discoloration of almost symmetrical tufts of the cilia of both upper lids, the lids and glands being normal. Some of the white cilia were full grown, others short and showed white apices on pigmented bases. The poliosis progressed within the following three weeks. No cause could be found, but an indirect one in the iridocyclitis.

A review of the incident literature shows a connection of poliosis of the cilia with severe iridocyclitis, especially sympathetic, in 39 per cent., with migraine in 11 per cent., with "cold" in 5 per cent., with no complicating disease in 39 per cent. Vogt studied in his patient the development of the white and pigmented cilia by epilating a portion of them and by cutting another portion close to the skin. Some of the latter, which apparently were full grown, did not return, others sprouted rapidly, i. e., were young cilia which had not been reached by the scissors. The clipped gray cilia retained their discoloration in growing, and those reappearing in the places of the epilated gray cilia were without pigment. However, they came more slowly and were thinner than the pigmented ones.

Vogt concludes that premature poliosis of the cilia depends upon the lack of pigment supply from the papilla. It is a gradual, not a sudden process, but the "trophic" disturbance may be due to neurotic or circulatory anomalies.

Ciliaramblyopie. (G.) Accommodative amblyopia.

Ciliarboden. (G.) Roots or base of the eyelashes.

Ciliarfortsätze. (G.) Processes of the ciliary body.

Ciliarfortsätze Gefässe. (G.) Ciliary processes.

Ciliargefässsystem. (G.) Ciliary vascular system.

Ciliaris. (L.), n. Orbicularis palpebrarum.

Ciliaris. (L.), adj. Ciliary.

Ciliaris circularis. (L.) The circular fibres of the ciliary muscle.

Ciliariscope. An ophthalmoscope provided with a prism for examining the ciliary region of the eye.

Ciliaris radialis. (L.) The radiating fibres of the ciliary muscle.

Ciliaris Riolani. (L.) A bundle of muscular fibres situated at the free margins of the lids.

Ciliarkörper. (G.) The ciliary body.

Ciliarkörpergefässe. (G.) Bloodvessels of the ciliary body.

Ciliarotomy. This is an operation recently suggested for the relief of the intraocular and other symptoms of glaucoma. It was devised by Abadie (*Archiv. d'ophthalm.*, May, 1910, p. 262) who, under the supposition that irritation of the rich circular nervous plexus which covers the ciliary zone immediately behind the insertion of the iris, may induce glaucoma, undertakes to relieve the condition by division of the ciliary zone, or as he terms it, by "ciliarotomy." The technique of the operation is as follows: "A fold of the bulbar conjunctiva is raised by means of forceps towards the supero-external quarter of the cornea. The conjunctiva, raised with fine dull-pointed scissors, is divided in the direction of the corresponding meridian of the eye for about 1½ centimètres. The conjunctiva being thus cleft, one takes the superior flap and with ordinary strabismus scissors detaches it from the sclera while raising it up, taking care, in order to disengage it well, to liberate its attachment to the sclero-corneal limbus by small cuts of the scissors. The inferior flap is treated in a similar way. By these means a large triangular surface of the sclera is bared, the base of which is formed by the cornea and the apex by the terminal point of the conjunctival opening made in the first instance. A couple of sutures are now passed through the two conjunctival flaps, whereby they may be brought together in order to cover the wound which is about to be made in the ciliary region.

"The sutures once in place, both are pulled outward in such a way as to expose the field of operation. Then, seizing with fixation forceps the conjunctiva and the episcleral tissue at the level of the inferior conjunctival flap, so as to keep the eye perfectly steady, the point of Richter triangular knife is inserted just at the junction of sclerotic and cornea, immediately behind the insertion of the iris. It is gently plunged, so to speak, into the globe, its point being directed towards the centre, and its blade in the corresponding part of the eye. In consequence of its triangular form, its propulsion towards the centre of the eye causes its cutting edge to divide the ciliary zone. By slight sawing movements of the blade, this section is enlarged in such a way that it attains a length of from 7 mm. to 8 mm.—that is to say about the extent of the ciliary nervous plexus. The knife is then withdrawn. Contrary to what might be expected, only one or two drops of vitreous issue from the incision, which is only a mere slit.

"Then, by tying the two sutures previously placed in the conjunctival flaps, the conjunctiva is brought together, thereby covering the scleral surface and the incision that has just been made."

Abadie asserts that his procedure is especially adapted to cases of glaucoma which persist despite iridectomy. The results have been uncomplicated, without luxation of the lens, or intraocular hemorrhage.—(W. C. P.)

Ciliarrand der Augenlider. (G.) The ciliary margin of the eyelids.

Ciliarsscheibe. (G.) A name for the ciliary body.

Ciliarstaphylom. (G.) A staphyloma in the ciliary region.

Ciliary. Pertaining to the ciliary body or region; relating to or possessing cilia; hair-like or pertaining to a hair-like structure; pertaining to the free border of the eyelid.

Ciliary arteries, Anterior. See pages 610 and 611 of this *Encyclopedia.*

Ciliary arteries, Posterior. See pages 611 and 612 of this *Encyclopedia.*

Ciliary arteries, The long. See page 611 of this *Encyclopedia.*

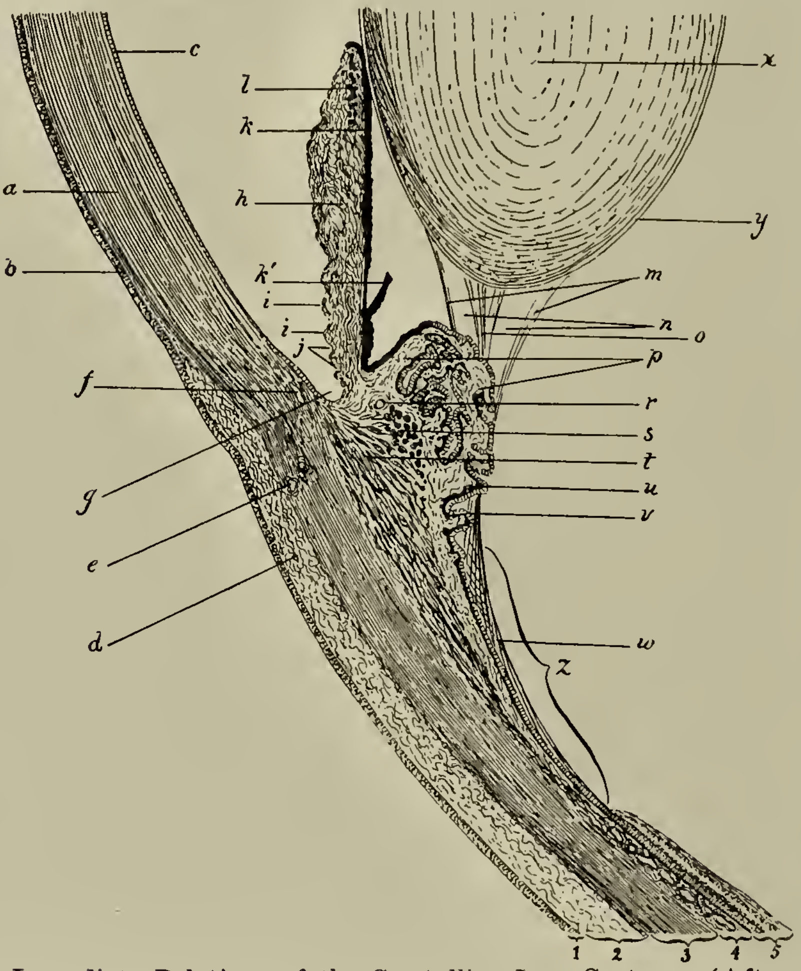
Ciliary body. This complex structure may be regarded as the intermediate section of the second, or uveal coat of the eye. It lies between the iris in front and the choroid behind and comprises the ciliary muscle, the ciliary ligament, and the ciliary processes.

Development of the ciliary body. This organ begins to develop relatively late in embryonic life and first makes its appearance as irregular folds in the retinal epithelium lining the optic cup. Gradually these folds deepen and increase in number, embracing the pigment epithelium. Into the depths of these grow capillaries and the ciliary mesoderm, which has developed in the ciliary region into a considerable mound. The ciliary muscle (Brücke's portion) which is of purely mesodermal origin, soon makes its appearance and its growth keeps pace with that of the *corpus ciliare.* As this advances, Müller's muscle begins to develop and the whole body advances slightly toward the angle of the anterior chamber. From the seventh month on, the changes in the ciliary body are merely those of size and position. Even at birth its development is incomplete, and the adult ciliary body is distinctly a product of extra-uterine development.—(H. G.) See **Embryology of the eye.**

According to Salzmann (*Anatomy and Histology of the Human Eyeball,* p. 107 "The ciliary body forms a girdle of about 5 to 6 mm. in breadth, narrower on the nasal side and above (4.6 to 5.2 mm.), broader on the temporal side and below (5.6 to 6.3 mm.). A meridian going obliquely from temporal and above, nasal and downward, separates the narrower from the broader part.

The *orbiculus ciliaris* is the broader of the two zones. Some 2 millimeters throughout belongs to the *corona ciliaris,* the rest to the *orbiculus ciliaris.* The significant difference in the breadth of the entire body depends, therefore, upon the expanse of the latter. In general, the inner surface of the *orbiculus ciliaris* is considerably darker than that of the choroidea. This depends, however, only upon the pigment epithelium. The following details of its color can be recognized under certain circumstances.

Immediately in front of the *ora serrata* its color is often darker than in the middle, or about a millimeter in front of the *ora serrata* one sees an especially dark girdle, which reproduces the zig-zag form of the *ora serrata* with absolute accuracy, although in a meridionally enlarged proportion, therefore exaggerated to a certain extent. Corresponding to the teeth of the *ora serrata,* there are narrow radial striæ which open into the corresponding valleys of the ciliary body. The dark girdle is not always visible; often it is developed only in the broader part of the *orbiculus ciliaris* and is entirely absent in many eyes. But the *striæ ciliares* are always to be seen except in those cases in which the pigmentation is, in general, so intense that one cannot make out any difference. The color is usually darker in front toward the *corona ciliaris.* Although one speaks of the *orbiculus ciliaris* as the flat portion of the ciliary body, this is not to be taken absolutely literally. For example, the dark girdle always shows a slight prominence when well developed. Slight differences in level are also to be found over the orbiculus. The same is true of the *striæ ciliares.* In the most anterior portion of the orbiculus, just behind the corona, one sees a system of little warts or folds in many eyes; these are very much smaller than the ciliary processes and only visible when looked at with the loupe under strong focal light (sunlight is best). These warts are elongated, sausage-like structures with their long diameters meridional; they are often arranged in chains and three or



The Immediate Relations of the Crystalline Lens System. (After Quain.)
a, Cornea; f, Canal of Schlemm; g, Iridic angle; h, Iris; k, Posterior pigment layers (detached); m, c, Zonular fibres; n, Interfibrillar spaces; p, r, s, t, Ciliary body; 1, 2, Conjunctiva; 3, Sclera; 4, Choroid; s, Retina.

four such rows are found in a ciliary valley. The corona ciliaris is much more uniformly developed throughout its entire circumference than in the *orbiculus ciliaris.* The difference between the nasal and temporal sides is slight and amounts to only a few tenths of a millimeter at the most.

The *ciliary processes* are described under **Anatomy of the eye** and **Histology of the eye.**

The *interspaces* (ciliary valleys) between the processes carry numerous similar projections; posteriorly these go over into the above-mentioned warts; in front they become larger and here and there they grow to especially large prominences (plicæ ciliares) in the neighborhood of the iris root, but they always remain much smaller than the ciliary processes. These plicæ are as darkly pigmented as the floor of the ciliary valley and, therefore, are not plainly visible in macroscopic examination. Finally, the whole system of elevations and projections is succeeded in front by a circular ridge which juts forth about opposite the border of the lens. Smaller irregularities in the development of the *corona ciliaris* frequently appear without particular reference to location; thus here and there the ciliary valleys are wider or the individual processes are notably lower than their neighbors.

The marked individual variations in this region have recently been elucidated through the excellent drawings by Hess. At its posterior border, the ciliary body is not any thicker than the peripheral parts of the choroidea; where the ciliary muscle begins, however, some 3 mm. behind the anterior border, the thickness of the ciliary body gradually increases and attains a maximum of 0.8 mm. at its very anterior border. With this maximal thickness the ciliary body ceases as such, as a rule, and thereby acquires a three-sided prismatic form; an outer surface is turned toward the sclera, an inner toward the vitreous, and a narrow anterior surface is turned toward the center of the cornea or the pupil. The ledge formed by the outer and anterior surfaces borders on the scleral roll; here one finds the insertion of the ciliary body into the sclera, as well as the anterior insertion of the uveal tract, in general. The inner and the anterior surfaces unite in a rounded ridge projecting in the direction of the border of the lens; this will be spoken of as the inner ledge.

The insertion of the iris root into the anterior surface lies in the neighborhood of this ledge, whereas the meshwork of the iris angle, in so far as it does not go over into the scleral roll, unites with the peripheral parts of the anterior surface of the ciliary body. There remains a narrow strip of the anterior surface between the two in many eyes; this is covered only by the innermost lamellæ of the trabeculum (the uveal meshwork) and so takes part in the limitation of the anterior chamber. In other cases the anterior layers of the iris extend to the scleral meshwork as a much-broken layer and so cover over this remnant of the anterior surface. The direction of the anterior surface varies even under normal conditions, and even more so when one takes into account eyes with an abnormally long axis; and, indeed, as follows: 1. The direction of the anterior surface is more nearly sagittal; if one erect a line perpendicular to the inner surface of the sclera at the inner edge, the foot of this line falls behind the scleral roll; the ciliary muscle is, in general, longer—the myopic type, so called because it is found in pronounced form in eyes with axial myopia. 2. The anterior surface is more frontally placed; the perpendicular line drawn from the inner ledge to the inner surface of the *tunica fibrosa* falls in front of the insertion of the ciliary muscle; the muscle is, in general, shorter—hypermetropic type—because it is found mainly in eyes of lessened axial length. Aside from these individual differences one notes differences as well between the nasal and temporal sides in many eyes, such as the ciliary body approaching the type of hypermetropia on the nasal side, and that of myopia on the temporal side.—(By permission, E. V. L. Brown.)

Ciliary body, Diseases of the. See **Uveal tract; Cyclitis; Uveitis.**

Ciliary body, Tumors of the. Neoplasms originating in, and parasites transported to, the iris are certain in time to involve the ciliary body, which, however, may also be the primary seat of a new growth or may be involved by metastasis. With the exception of tubercle and gumma, primary tumors of this part of the eye are very rare. Such a growth will cause iridodialysis, increased intra-ocular tension, repeated hemorrhages into the anterior chamber, and loss of the eye. By focal illumination the tumor can sometimes be seen as a dark mass lying behind the iris. The diagnosis will be difficult if the eye is painful and hard, without the tumor presenting. The presence of nodules or bulging at the ciliary region will show that the neoplasm is about to break out. The following growths have been observed: sarcomata of various kinds, myomata and fibromyomata, carcinomata, and angiomata. The *prognosis* is serious, and the proper *treatment* is enucleation of the eye or exenteration of the orbit. Calcification and ossification are rarely found in this region. Parasites have been found in the ciliary body. In a few cases cysts have been found.—(J. M. B.)

Akatsuka (*Klin. Monatsbl. f. Augenheilk.*, November, 1912) reports a case of ciliary body sarcoma which, contrary to what has hitherto been observed, grew through the pupil into the interior chamber, a complication heretofore observed only in new growths of the retinal iris and ciliary pigment. Sarcomata of the ciliary body usually grow out through the angle of the anterior chamber. Fuchs saw the case before enucleation and thought the growth originated in the retinal epithelium of the iris or ciliary body. The case demonstrates that ciliary sarcomata may simulate growths of the retinal epithelium.

Coover has also reported (*Annals of Ophthalm.,* October, 1912) the history of an instance of small spindle-celled sarcoma of the ciliary body in a woman sixty years of age. The patient was first seen July 6, 1911. About two years previous she had noticed a dimness in the vision of the right eye, which gradually became worse until the vision was reduced to light perception. The eye was watched for a year by an optician, who made a diagnosis of cataract. At this time there was some pain, but she had not suffered previously. The attack lasted about twenty-four hours and the eyeball pained when she pressed on it. Examination showed tension plus 1 with some congestion of the ciliary region. A dark brown growth lay in direct contact with the anterior surface of the lower half of the iris. It appeared to come from behind that structure and extended upwards to the edge of the pupil, pushing the lens backward. The lens was opaque. The growth measured in situ 8 mm. at the base and 6 mm. at the apex. Diagnosis: melanotic sarcoma. Enucleation was advised and performed four days later. Francis Lane examined the specimen microscopically and reported it to be small spindle-cell sarcoma, originating from the ciliary body. No remnant of this structure or the root of the iris escaped destruction, except a few blood vessels. The dark color of the tumor was due to the presence of large masses of hematogenous pigment.

Reis describes (*Zeitschr. für Augenheilk.,* p. 426, November, 1912) a case of ring sarcoma of the ciliary body. He found on the sclera above the cornea a flat black tumor, whose anterior border did not reach the limbus. At some distance a small black spot was visible on the nasal and temporal sides, a few millimeters from the limbus. This peculiarity as well as its seat at a distance from the limbus made a primary epibulbar tumor improbable, and suggested an intrabulbar melanosarcoma. This was further proved by the dark brown (here and there black) color of the iris with a peculiar dotted and streaky outline, whereas the left iris had a bluish grey hue. Diascleral illumination with Sachs' lamp left the whole upper circumference of the pupillary area dark and made the diagnosis certain. Enucleation was performed, and the patient has been healthy and free from relapse now for two years. This patient was at first treated by radium, but without improvement.

Fuchs (Graefe's *Archiv. für Ophthal.,* LXVIII, 3, p. 534) discusses in detail a series of cases of tumor of the ciliary epithelium which have come under his notice, and takes the opportunity to pass in review also the cases hitherto published by others, of many of which he has been able to obtain sections for his personal investigation. On this basis he attempts a systematic classification of the tumors, innocent and malignant, which are derived from the epithelial layers of the ciliary body.

First he describes in a class by themselves the simple outgrowths or overgrowths (Wucherungen) of the ciliary epithelium, which may be of senile or of inflammatory origin. These may affect either the unpigmented layer, the pigmented layer or both layers. In their simplest form they consist of local thickenings of the epithelial layers, due to enlargement of a few cells with multiplication of their nuclei. By further growth these may come to form club-shaped projections. The larger growths assume the form of cellular strands or cellular membranes. The former are found chiefly projecting from the pars plana as if stretched out by the tension of the zonular fibres. The membranous growths are formed by the coalescence of neighboring overgrowths of cells. The cellular membrane is separated from the ciliary epithelium by a narrow layer of homogeneous material, and several such layers may be superimposed one on the other, always with an intervening layer of non-cellular material. In the inflammatory cases the cells become altered in form and in arrangement, become pigmented and may undergo retrograde changes such as vacuolation or fibrillation of their protoplasm. When it is the pigmented layer from which the outgrowths spring, the cells may lose their pigment. Thus it sometimes becomes difficult to ascertain the source of the growth. The cells of the pigmented layer may proliferate inward towards the vitreous or outwards towards the ciliary body. In the former case they may either raise the unpigmented layer or break through it. In some cases the proliferation of cells of the unpigmented layer may give rise to a projecting fold, between the two layers of which a space forms, and thus a cystic swelling develops.

Coming to the tumors properly so-called, Fuchs offers the following provisional classification:

I. Innocent tumors (so-called adenomata).

II. Malignant tumors.

   1. Having the structure of the embryonic retina (Diktyoma).
   2. Whose structure does not represent the whole retina but at most the simple ciliary epithelium. These consist of either
      - *a.* Cellular membranes with a single layer of nuclei, combined with cellular tubes.
      - *b.* Cellular tubes alone, or
      - *c.* Cells grouped in an irregular fashion, with only a few tubular formations in the youngest parts.

Of the innocent tumors twenty have been reported, five of these by Fuchs himself. They occur in elderly persons, and as a rule give no clinical evidence of their presence, having a diameter of less than 1 mm. (The exception is the case of Coats in which the tumor had a diameter of 4 or 5 mm. and caused visible elevation of the periphery of the iris.)

The little tumor is situated at the summit of a ciliary process and arises from the unpigmented layer. This grows out into the substance of the ciliary process, and carries before it the pigmented layer. We thus come to have an invagination of both layers of the ciliary epithelium, whose lumen communicates with the interior of the eyeball. Ultimately by the enlargement of the lumen an actual cyst may form.

The tumor is distinguished from a true adenoma by the absence of any stroma and by the direction of the growth. Other names which have been suggested for it are epithelioma benignum or euthelioma, but Fuchs prefers to call it simply innocent tumor of the ciliary epithelium.

Of the malignant tumors, in class 1, the author places four published cases, all of which occurred in young subjects. The tumor is unpigmented, arises from the ciliary body and grows superficially over the ciliary body, iris, posterior surface of the iris and anterior surface of the lens. It causes rise of ocular tension by blocking the filtration angle, and at a later stage infiltrates the tissues, forming compact masses in the ciliary body and proliferating outwards in the sclera. All the eyes were enucleated before perforation of the sclera occurred.

The characteristic constituents are (a) Cellular membranes containing several superimposed layers of nuclei, and thus resembling the embryonic retina before its differentiation into layers; (b) Cellular membranes containing a single row of nuclei, corresponding with the unpigmented layer of the pars ciliaris retinæ. Sudden transitions from (a) to (b) may be seen, resembling the transition from the pars optica into the pars ciliaris retinæ. Sometimes the cells form structures like the rosettes seen in glioma of the retina, the lumen being as a rule lined with a limiting membrane, apparently representing the limitans externa. (c) Atypical arrangements of the nuclei, where the tumor forms a compact mass, as, for example, in the substance of the ciliary body. (d) Single or double rows of cells, where the tumor is infiltrating the sclera.

As regards the origin of these tumors, the author agrees with Emanuel and Verhoeff that they arise in the pars ciliaris retinæ, either as a reversion to the embryonic structure, or by proliferation of persisting embryonic elements.

The names which have been suggested for this class are carcinoma or adeno-carcinoma (Lagrange), teratoneuroma or neuroma embryonale (Verhoeff), malignant epithelioma of the ciliary body (Kuthe and Ginsberg), glioma of the pars ciliaris (Emanuel). The reasons for and against these names are discussed, but the author prefers to reserve the name diktyoma for these tumors of the ciliary epithelium which represent the embryonic retina.

Class 2a is represented by the single case published by Treacher Collins (*Trans. Oph. Soc.*, XI, 1891), a pigmented tumor arising from the pigmented layer of the ciliary epithelium and growing into the substance of the ciliary body and iris.

Class 2b is represented by a single case published by Ernest Fuchs. The tumor, a pigmented one, was found in an eye which had been the seat of a plastic endophthalmitis with formation of bone in the exudate. It consisted of an annular tumor of the ciliary body and a number of separate nodules in the posterior segment of the eyeball. The cells grouped themselves in rows or in tubes or in atypical fashions, but everywhere the essential structure was that of epithelial cells without intercellular supporting tissue. Retrograde change in many parts obscured the "typical" structure. In the ciliary region the tumor was growing from both layers of the ciliary epithelium (the supposed primary focus), other nodules in the posterior segment of the eye were growing from the pigment epithelium of the retina, while other nodules in the interior of the eye could not be traced into connection with either of these and were probably local metastases.

As representative of Class 2c, the author describes a case published by Schlipp from the clinic of Fuchs in 1899. This tumor also was found in an eye which had passed through a plastic endophthalmitis with formation of bone in the exudate. It originated in the ciliary epithelium, grew into the ciliary body and into the organized exudate, filled the interior of the eyeball, penetrated the choroid and was growing in the supra-choroidal space. As in the last case growth was found to have taken place both from the ciliary epithelium and from the pigment epithelium of the retina. Only in the younger parts were the cells arranged in tubes or thicker lobules, the greater portion of the tumor formed a compact mass. Retrograde changes as in the other tumors led in parts to entirely atypical appearance.

The malignant nature of these three tumors (a, b, and c) was clearly established by their mode of growth. While they are described as separate forms, the author thinks it possible that their essential unity may be established by the discovery of transitional forms. (Abstract, *Oph. Review,* October, 1908, by Arthur J. Ballantine.)

Ciliary canal. Canal of Fontana.

Ciliary circle. Ciliary ligament.

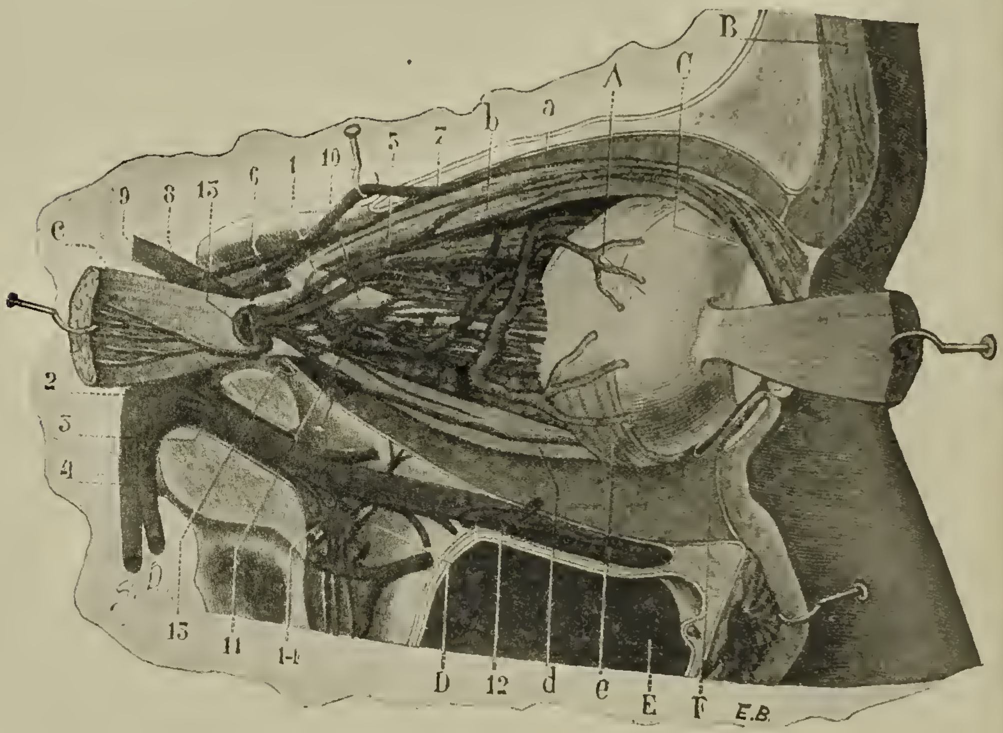
Ciliary corona. According to Tscherning, if one looks at an intensely luminous point it is seen to be surrounded by an infinity of very fine, many-colored radiations, the whole of which is known under the name of *ciliary corona.* Its extent varies with the intensity of the luminous point. If the latter is very bright (a reflected image of the sun) the diameter of the corona may reach 8 degrees or more. The cause of the phenomenon is, in all probability, to be found in the fibrous structure of the crystaline lens.

Ciliary disc. An obsolete term for ciliary body.

Ciliary folds. These are small plications that appear between the ciliary processes, and seem to be simple continuations of the orbicular striæ. See **Ciliary processes**; as well as **Ciliary body.**

Ciliary follicles. Meibomian glands.

Ciliary ganglion. OPHTHALMIC GANGLION. LENTICULAR GANGLION. This important organ is a small quadrate body about the size of a pin's head. It is placed at the back part of the orbit internal to the external rectus muscle. It can be found by tracing the branch of the third nerve to the inferior oblique backward, when the ganglion will be seen. The ganglion receives the long root of the nasal nerve at its upper posterior angle; into its lower posterior angle the short, thick root passes from the nerve to the inferior oblique; and several fine filaments from the cavernous plexus of the sympathetic enter its posterior border. The branches from the ciliary ganglion are given off anteriorly, and are about six in number, called the short ciliary nerves. These pass forward in the perineural space, accompanying the short ciliary arteries, and each branch divides into several, so that there are about twenty nerves. They pierce the sclera, pass forward in delicate grooves on its inner surface, and are distributed to the ciliary muscle, iris, and cornea. Before reaching the eyeball they are joined by filaments from the nasal nerve. The branches of communication of the ciliary ganglion are: The motor branch from the motor oculi; the sensory, from the nasal nerve; and the sympathetic, from the cavernous plexus.—(J. M. B.)



View of the Orbit, Showing (10) the Ciliary Ganglion and Its Connections. (After Testut and Jacob.)

A, Eyeball. B, Skin and muscles of the forehead. C, Conjunctiva. D, Pterygomaxillary fossa. E, Maxillary sinus. F, Orbital adipose tissue. a, Levator palpebræ superioris muscle. b, Superior rectus muscle, with its nerve. c, External rectus, with its nerve. d, Inferior rectus, with its nerve. e, Inferior oblique, with its nerve. 1, Optic nerve. 2, Ganglion of Gasser. 3, Superior maxillary nerve. 4, Inferior maxillary nerve. 5, Nasal nerve. 6, Lacrimal nerve. 7, Frontal nerve. 8, Fourth nerve. 9, Motor oculi nerve. 10, Ophthalmic ganglion. 11, Ophthalmic artery. 12, Infraorbital artery. 13, 13′, Superior and inferior ophthalmic veins. 14, Ganglion of Meckel, with its branches.

Ciliary ganglion anesthesia. GANGLION ANESTHESIA. This subject is discussed under **Anesthesia in ophthalmic surgery,** page 436, Vol. I. of this *Encyclopedia*. J. S. Wyler (*Ophthalmic Record,* Vol. 22, p.

302, 1913) has written favorably of it and there is no doubt but that under certain conditions it has an important place in ophthalmic surgery.

Ciliary glands. Treacher Collins, in 1890, gave this name to certain recesses in the surface of the ciliary processes, since they much resemble, on section, the lumen of true glands.

Ciliary injection. A synonym of ciliary or circum-corneal congestion.

Ciliary muscle. This important ocular structure was first demonstrated microscopically in 1835, by Wallace, an American; although Eustachius probably discovered it about 1570.

It is pictured under **Ciliary body,** and the reader is referred to that illustration, as well as to **Anatomy of the eye** and **Histology of the eye,** that he may better understand the following description from the Salzmann-Brown *Anatomy and Histology of the Human Eyeball.* The ciliary muscle proper develops from the *suprachoroidea* in the shape of smooth muscle fibres. They are grouped in bundles or as muscle-stars. The bundles are disposed in various ''planes,'' unite with one another and the muscle mass becomes thicker and thicker through further branching. This structural framework is maintained throughout the entire ciliary muscle, only the prevailing direction changes gradually, so that the ciliary muscle falls into various portions. In the outer layers of the muscle the bundles have an almost pure meridional direction, i. e., the meshes of the framework are narrow and drawn out in the meridional direction; therefore, one sees almost no intermediary tissue. The respective layers of muscle-bundles, indeed, show many unions in the direction parallel to the surface, but among themselves these bundles are only sparsely united with one another; the suprachorioidal lamellæ go deeply in between these layers and their denser pigmentation can be followed for a long distance into the muscle. This portion of the muscle itself, therefore, appears to be lamellated and on meridional section to be composed of many longitudinally disposed bundles. It is called the *meridional portion,* from the direction of the bundles. Forward the thickness of this portion gradually increases up to one-third of the maximum of the entire muscle. At the very fore part it again thins and ends at the scleral roll: the muscle-fiber bundles go over into finely fibrillated connective tissue, likewise of a meridional course; this tissue presses in between the circular bundles of the scleral roll and probably continues farther into the lamella of the scleral trabeculum. Occasionally individual cross-sections of bundles are seen at the anterior end of the meridional portion. The suprachorioidea is at length completely lost in the meridional portion of the ciliary muscle;

the majority of the lamellæ enter the posterior border of the ciliary muscle along with the muscle-stars, and the few lamellæ which lie outside this gradually go over into the muscle-bundles from the outer surface. So it comes about that the most anterior part of the perichorioidal space is entirely free of suprachorioidal lamellæ. Not infrequently one sees a short muscle-bundle inserted into the *lamina fusca scleræ* at the very front, and, therefore, not taking part in the general detachment of the ciliary body. The *radial portion* succeeds the meridional portion inward. In this the structure of the framework is most pronounced and the section, therefore, shows an irregular net-form marking. Many of the bundles appear to end blind; these are the obliquely coursing bundles whose continuation falls in the next section. The interstices of the framework are filled out by a pretty dense connective tissue, which carries the blood-vessels and the especially numerous nerve branches, and in heavily pigmented eyes also contains a few scattered chromatophores. This portion received its name from the fact that a fan-like radiation of the surface was read out of a divergence of the bundles. Yet one is at great pains to find such an arrangement of the musculature, and I would prefer to call it the reticulated portion. The radial portion attains its greatest thickness in the neighborhood of the inner ledge of the ciliary body. A special ending is not to be ascribed to this portion, for the framework turns back into itself. For example, this closure of the framework by means of many circular coursing muscle-bundles is to be seen in the form of a net along the inner surface of the muscle. The union with adjacent structures, especially the surface union with the vessel layer of the ciliary body, is only mediated by the interstitial connective tissue of the muscle, which goes directly over into the connective tissue of the vessel layer. In a similar way the anterior end of the radial portion unites with that portion of the scleral framework which does not enter the scleral roll: the connective tissue substratum of the trabeculum of the iris angle goes over into the interstitial connective tissue of the muscle. On the side of the anterior chamber, in the delimitation of which just this portion of the muscle takes some part, the muscle framework is bordered by a thin layer of connective tissue united with the meshwork of the iris angle, on the one hand, and with the iris stroma on the other. This layer, as well as the most anterior portions of the interstitial tissue, is especially rich in fine, wavy, elastic fibers; these are pressed together at the inner border of the scleral roll, for instance, and radiate out from here toward the root of the iris and into the muscle. Chamberward the trabeculæ of the uveal meshwork course to the root of the iris covered by and snugly inclosed in this layer. In general, this layer varies greatly in its density and composition in various individuals. At the inner ledge of the ciliary body lies the *circular portion* of the ciliary muscle, the so-called *Mueller's muscle,* named after its discoverer, Heinrich Mueller. As its name indicates, it is characterized by the circular course of the bundles and, therefore, appears as a group of cross-sections in the meridional section. The intermediary tissue is looser than in the radical portion; it has more of the appearance of the stroma of the iris, whose root lies just in front of this portion. But the circular portion likewise forms only a part of the muscle framework; the meshes are much drawn out in a circular direction, and do not form a separate part independent from radial portion. Unions and transitions between the two portions occur, so that in most sections one cannot state exactly how far the circular portion extends. In any case the drawings of Iwanoff do not correspond to the actual conditions in this respect. The form of the ciliary muscle, especially, and thereby that of the entire ciliary body, depends upon the grade of development of the circular portion. In the myopic type the circular portion is very weakly developed or fails entirely; in the hypermetropic type it is very strongly developed, on the other hand, and, therefore, causes the inner ledge to project forward and inward.

It at once comes to mind that these various types of the ciliary muscle are nothing more than the expression of the particular requirements of accommodation for the refraction concerned. For the hyperope, who must accommodate for distant vision, certainly uses much more accommodation in his whole life than does the myope, who can work even at near objects without any particular accommodation. But this relationship must not be so conceived of that the ciliary muscle of the hyperope is thought of as hypertrophic, and that of the myope as atrophic, because the whole mass of the muscle in the myopic type may be even greater than in the hyperope. Now Heine has shown that the eserinized (contracted) muscle approaches the hyperopic type, the atropinized (relaxed) muscle the myopic type. It is, therefore, conceivable that the different types are nothing more than different states of contraction of the muscle. Against this it is to be argued that, as a rule, there is not occasion for the hyperope to accommodate just before the eye comes to anatomic study, as for example in the last hours of life if the eye is removed from the cadaver, nor doing the anesthesia if it is enucleated during life. Finally, the same variations are found even in the new-born. All things considered, one must conclude that the form of the ciliary muscle depends upon its length, i. e., the longer the muscle from whatever cause, the more the myopic type comes to expression, the shorter it is, the more the hypermetropic type comes out. The transitory changes in its length, by contraction, have the same effect as the permanent ones—those which develop either as a congenital variation or as a result of the elongation or shortening of the sagittal diameter of the eye.

The fibers which make up the ciliary muscle are ordinary smooth muscle-fibers, although the nuclei are not so markedly rod-form but more oval than is generally the case.—(By permission, E. V. L. Brown.)

Ciliary muscle, Hyperesthesia of the. (Nagel.) This is another name for that hysterical anomaly of accommodation—generally paretic or spasmodic in character—known as the "painful accommodation of Donders" and the "hysterical kopiopia of Förster."

Ciliary muscle of Riolan. These muscular fibres have nothing to do with the ciliary body, although the name might give that impression. This muscle is made up of a few bands of fibres, running in a distinct group, near the margin of the eyelid. (See p. 346, Vol. I, of this *Encyclopedia.*)

Ciliary plexus. This bundle of nerve fibres is formed by the long and short ciliary nerves which are then supplied to the cornea, ciliary muscle and iris.

Ciliary processes. These organs have been discussed on page 385, Vol. I, of this *Encyclopedia.* It may be added here that C. Hess (*Archives of Ophthal.,* Jan., 1912) has described different normal eyes as they appear in the brilliant rays of a Zeiss arc light, magnified twenty times. It is seen that in an infant the *ciliary processes* are narrow, thin bands fairly far apart, with flat irregular folds between them, that the surface of the processes is uniformly pigmented and that a considerable space separates their apices from the margin of the lens. In the eye of the 80-year-old man the individual processes are thicker and plumper, often thickened like clubs toward the lens; the intermediate spaces between the individual processes are much smaller; at the bottom of these spaces numerous lumpy or sausage shaped knobs are visible. The summits of the processes, which in the infant form straight, dark, comparativley narrow stripes, here appear to be white, irregular, much broader, and studded with bulbous outgrowths. The distance from the lens is considerably less than in the infant, the broad, clubbed processes reach in many cases to the equator, in other eyes they extend more or less toward the anterior surface of the lens. The ciliary process of an 80-year-old man is, in the neighborhood of its apex, about three times as thick as in the infantile eye. The iris itself, especially near its root, is not infrequently twice as thick in the eyes of old people as in those of infants. The vessels in the senile iris often are distinctly visible as grey tubes, while in young eyes little or nothing can usually be perceived. See also, **Histology of the eye.**

Ciliary region. Ciliary zone. The pericorneal or "danger" zone, externally outlined but corresponding to the position of the ciliary body, within the globe. See **Corneoscleral junction.**

Ciliary retina. When the retina reaches the ora serrata the nerve elements of the former suddenly disappear, so that only the external pigmented epithelium and an internal layer remain. At this juncture the retina is reduced in thickness and measures 0.2 mm. It is then continued anteriorly with the pigmented epithelium of the iris.

Ciliary ring. This is one of the divisions of the *ciliary body,* which appears as a thick, smooth zone about 4 mm. wide, and extends from the anterior margin of the choroid proper (opposite the *ora serrata*) forward to the base of the irregular projections that mark the inner surface of the neighboring portion of the ciliary body.

Ciliary zone. See **Ciliary region.**

Ciliation. Provided with cilia.

Ciliectomy, Total. Complete extirpation of the eyelashes and the tissues from which they grow, mostly done for the relief of post-trachomatous malposition of the cilia. This "scalping" of the lids belongs to medieval methods in ophthalmic surgery, but has had some later advocates.

Cilien. (G.) Cilia.

Cilien Ausfall. (G.) Falling out of the eyelashes.

Cilienpincette. (G.) Epilation forceps.

Ciliometer. A name suggested by Savage (*Ophthalmic Myology,* p. 563) for a device to be used in testing the relative power of accommodation. He employs two parallel bars containing a series of concave spherical lenses, varying in strength from .50 to 3. D, the difference in strength between any two adjacent lenses being .50 D. These bars should be so connected above that the distance between them may be regulated to suit the distance between the pupillary centers of the eyes to be tested. The minus .50 should be below; the minus .3 D sphericals, above. Beginning with minus .50 sphericals before the two eyes, the patient all the while looking at the Snellen letters made to be read at twenty feet, each pair of lenses should be passed down in front of the eyes so long as the patient is still able to see $\frac{20}{\text{xx}}$.

If the muscles of accommodation are weak, ciliary power, unassociated with convergence, will be less than 3. D; in many cases it is not more than 1. D. The standard of ciliary power, when unassociated with convergence, may be placed at 3. D, for the reason that a ciliary muscle that can overcome a minus 3. D, when not converging, can easily accommodate for the reading distance, in association with convergence.

Cilioretinal artery, Embolism of the. As before stated (see page 615, Vol. I, of this *Encyclopedia*) examination of the ocular fundus shows that in 10 per cent. of the cases some branches of the retinal artery supplying the macula have their origin within the papilla. These vessels, called *cilioretinal* by Nettleship, originate from the coronal or scleral vessels, and thus carry blood from the ciliary arteries.

Edward Jackson (*Ophth. Rev.*, October, 1911, p. 264), reports that the ophthalmoscopic examination of 500 patients (1,000 eyes), presenting consecutively in private practice, has yielded the following facts. To determine whether a particular vessel be an artery or a vein, the observer relied upon noting whether it crossed venous or arterial branches. Arteries cross veins, and veins cross arteries; but in the retina he had never observed two veins or arteries crossing each other (except as they may wind over each other at the optic disk) before passing to their areas of distribution. The test seems practically reliable in this connection. Some such test is necessary because many of the cilioretinal vessels are so small that one cannot tell by their color whether they are arteries or veins.

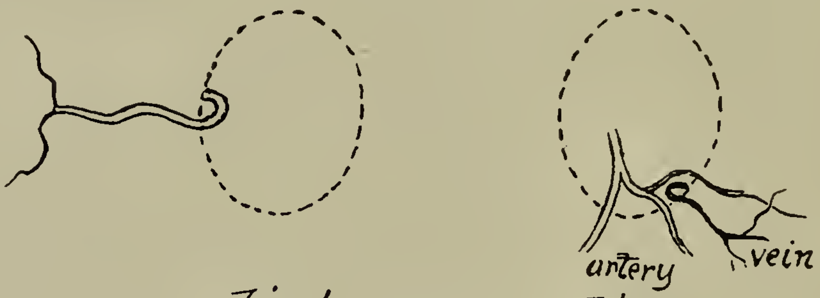


Fig. 1 Fig. 2

Cilio-Retinal Vessels. (Jackson.)

Cilioretinal veins are quite rare as compared with arteries. But perhaps systematic search might show them less rare than we have supposed. This series includes two cases.

Cilioretinal arteries were found in about 20 per cent. of all eyes examined. Including the three eyes mentioned above, they were found in 191 eyes, 19.1 per cent. In addition to these there were 40 eyes which presented vessels so completely isolated from the branches of the central retinal vessels, as to make it probable that they arose from the central retinal artery. (See the figures.)

A general impression previously obtained, that in normal conditions visible pulsation is more frequent in cilioretinal arteries of equal size, than in the branches of the central retinal artery, has been confirmed by this statistical study.

An exhaustive account of these vessels is also given by Elsching in Graefe's *Archiv. für Oph.*, Vol. 44, 1.

Embolism of a cilioretinal artery is quite uncommon. According to F. Krause, who has reported and pictured an example of the kind (*Ophthalmic Record,* 1907, Vol. 16, p. 186), "H. Knapp, in 1868, described two cases of embolism of the cilio-retinal artery, in one of which a post-mortem examination was made, the patient dying of thrombosis of the cavernous sinus and jugular vein on the right side. The right eye was affected, the region between the macula and optic nerve being involved.

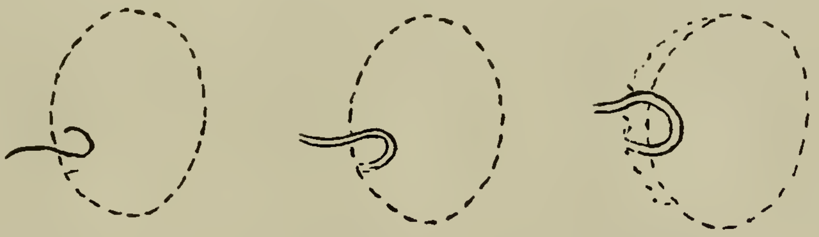


Fig. 3 Fig. 4 Fig. 5

Cilio-Retinal Vessels. (Jackson.)

Microscopically, large numbers of pale, light, yellowish, semi-transparent, finely stippled, homogeneous spheres or plates, the diameter of which were 1½ to 2 times the diameter of a nucleus, were found especially in the outer nuclear layers and outer molecular layers, none being found in the inner nuclear layer. These colloid masses, Knapp thinks, consist of protoplasmic cells in which the nucleus is hidden, and account for the cloudiness of the retina in embolism."

In the report of Krause, there was a good-sized cilioretinal artery arising from below the center of the optic nerve head near the temporal border. The artery passed up vertically for about one-half disc diameter, making a sharp loop. It then dropped to a point opposite the center of the disc, when it bent again sharply and ran to the macular region, sending out several branches, and finally divided into two terminal branches.

The artery had a caliber of one of the larger branches of the inferior temporal artery to a point about one-half disc diameter from the papilla, where it was smaller and lay upon an opaque area of the retina. The opaque area reached from the constricted portion of the cilio-retinal artery (where it was broadest) to a point one-half disc diameter beyond the macula lutea, the upper part of which was directly involved, the lower part being cherry red in color contrast. (See the figure.)

The part of the retina which is opaque corresponds accurately with the parts supplied by the cilioretinal artery. The upper and lower margins are festooned, and are limited above by a tortuous branch of the superior temporal branch, below by branches of the inferior temporal branch supplied to the macula. The upper part of the macula is apparently entirely supplied by the cilioretinal artery, while below there are several branches of the inferior temporal artery running directly into the macula.

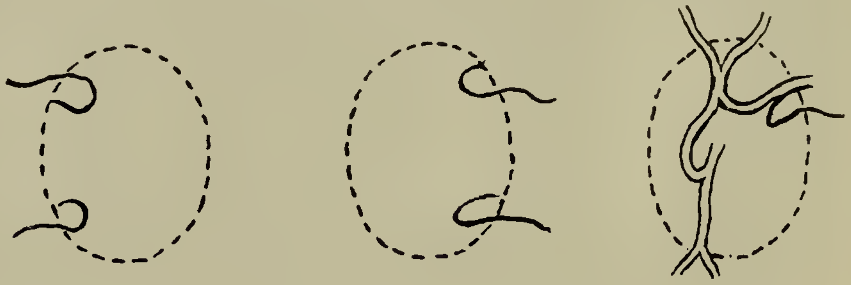


Fig. 6 Fig. 7 Fig. 8

Cilio-Retinal Vessels. (Jackson.)

The portion of the retina between the disc and the obstructed cilioretinal artery was nearly normal when first seen, but two days later it became opaque and the temporal edge of the disc became veiled. The artery in advance of the obstruction gradually became smaller. The eyeground of the left eye was apparently normal.

Krause further reports that the field of vision of the right eye shows a large section extending from the physiologic blind spot to a point of 5° to the nasal side, and it extends through an arc of 90° along a line 20° from the macula. The upper nasal sector is entirely free.

The scotoma is relative for white and red, except through a horizontal area about 5° wide extending from 5° beyond the macula to the physiologic blind spot, where it is absolute. In taking this field the patient could only see the upper edge of the fixative point.

Six days later the scotoma was much smaller, the patient claiming that the scotoma was absolute except in center and about 5° to 10° wide and 20° long.

Twenty-three days later the scotoma was but 5° at its widest and 15° long, with only a small area of absolute scotoma at both ends; 39 days after the accident there was only a small section from fixation slightly down and to 10°.

Corresponding to these changes in the field, it was interesting to note how the mildness of the retina gradually became less, like a melting snowpile, the periphery first becoming transparent. The opaque area gradually assumed the appearance of a retinal reflex and finally the appearance of normal retina.

The cilioretinal artery when first seen was fairly well filled on both sides of the obstruction, but gradually became smaller, so that at the present time it is a mere thread filled with blood. The optic nerve finally lost its haze.

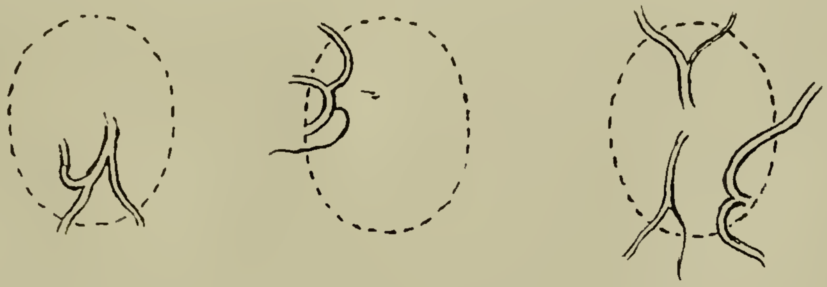


Fig. 9 Fig. 10 Fig. 11

Cilio-Retinal Vessels. (Jackson.)

A. Levy (*Ophth. Review,* March, 1909, p. 88) gives the history of a patient, a girl aged 22, who complained that 6 days previously the vision in the right eye suddenly failed. During a previous visit to Moorfields on account of squint her vision had been recorded as 6/6; it was at the present time 6/60. Stretching for 3 or 4 disc-diameters outwards was a broad patch of exudation, coinciding with the distribution of a vessel beginning at the outer margin of the disc—a cilioretinal artery evidently obstructed. There was some evidence of arteriosclerosis in the other retinal vessels.

Meller (Graefe's *Archiv. f. Ophthalm.,* 72, 3, 1910) reports an unusual and interesting example of this form of embolism which has been abstracted by R. R. James in the *Ophthalmic Review,* for July, 1910. A married woman of thirty-five years of age suddenly became aware of a blinding sensation in the left eye, and on shutting the right eye saw a cloud moving in front of the left; there was also a stabbing pain in the præcordial region. For the last two years she had been under treatment for some uterine trouble dating from the birth of her last child: catamenia had begun two days before, had been in abeyance for a day, and had recurred profusely on the day the blinding sensation was noticed.

The patient's general condition was good, though examination revealed a pleuritic rub on the left side of the chest.

On admission the right eye was found to be healthy in every respect, and vision was 6/6, the vision in the left eye was reduced to counting fingers at a metre, and the fundus examination revealed a state of affairs, which is well shown in the accompanying lithograph. The outer half of the disc was pale, and its boundaries were not quite so clearly defined as on the right side, there was a small cilio-retinal artery starting from the inner edge of a small temporal crescent, and running outwards towards the macula; the retina to the outer side of the disc was edematous, and of an opaque grey color, and there was a typical cherry-red spot at the macula: the central vessels were normal in appearance, but their macular branches were practically non-existent, their place being taken by cilio-retinal vessel described.

On pressing on the globe with the finger the central retinal artery pulsated, whereas the cilio-retinal collapsed. There was an absolute central scotoma of 10° breadth.

Next day fine pulsations could be detected in the cilio-retinal vessel, and a week later vision had risen to fingers at two metres, the scotoma had shrunken on the nasal side almost to the fixation point, but still had a breadth of 5° on the temporal side.

At the end of a month vision was 6/36, the scotoma extended for 5° just outside the fixation point, the outer half of the disc was pale, and the edema had disappeared.

Meller finds only three similar cases in the literature, those reported by Hirsch, Zentmayer and F. Krauss; he thinks that vessels of small size may be obstructed without the patient being aware of anything being wrong, as long as the scotoma is not central, especially if the other eye is sound; in other words that if the macula in his patient had been supplied with larger twigs from the central vessels, the obstruction of the small cilio-retinal one would possibly not have been noticed.

The *etiology* and *pathology* of cilioretinal embolism is that of the embolism of the central artery of the retina (q. v.).

The *prognosis* is always grave. The *treatment* of these cases, like the conduct of embolism of the central artery, is deep massage of the globe, the use of amyl nitrite, the internal administration of one-hundredth of a grain of nitroglycerin every three hours, and complete rest of the eyes. In very few cases is any form of treatment effective in preventing functional death of the parts supplied by the obstructed artery.

Cilio-spinal. Relating to that part of the spinal cord that influences or controls the movements of the ciliary muscles.

Ciliospinal centre. The centre for the sympathetic nerve, for the *dilatator pupillæ* and for the muscle of Müller lies in the lowest cervical and uppermost thoracic segments of the cord. In man these fibres leave the spinal cord with the anterior roots of the first thoracic nerves and, perhaps in part also, through the eighth cervical root. In experiments on cats, dogs and rabbits sympathetic fibres which dilate the pupil were found even in the seventh cervical and the second thoracic nerves. Budge, who discovered this centre, located it between the sixth cervical and the fourth thoracic vertebræ and called it the *centrum ciliospinale inferius* in contradistinction to a second centre for dilatation which he suspected to exist higher up, and which he called the *centrum ciliospinale superius.*

Ciliospinal centre, Budge's. See **Budge's ciliospinal centre.**

Cilium. (L.) Generally used in the plural, *cilia.* See **Cilia** and **Eyelashes.**

Cilium forceps. An instrument for the removal of the eyelashes: generally known as epilation forceps. See **Instruments.**

Cilium in the cornea. Alt (*Lectures on the Human Eye,* 1880) was probably the first to describe this condition, which is that of a foreign body carried into the corneal tissues. As a rule the cilium, as it is generally infected, produces distinctly inflammatory results, although in some instances it remains *in situ* without causing symptoms. The inflammatory reaction is shown by the development of giant cells—according to Schwarz (Graefe's *Archiv f. Ophthal.,* 1898), typical myeloplaques. As in the case of cilia implanted in the iris the epithelial cells about the root-sheath proliferate and may form pearly cysts.

Cillement. (F.) Nictation.

Cillo. (L.) Obsolete. A person affected with chronic spasm or trembling of the eyelids. Also written *cillon.*

Cillosis. (L.) A spasmodic affection in which the eyelids are in a constant state of agitation or trembling.

Cils. (F.) Eyelashes.

Cils palpébraux. (F.) The eyelashes.

Cils renversés. (F.) Inverted lashes; entropion.

Cimex lectularis. The common bed-bug. See page 921 of this *Encyclopedia.*

Cimicifuga racemosa. (L.) BLACK COHOSH. This plant, whose generic name is derived from its supposed virtues in driving away *(fugere)* the bed-bug *(cimex)*, is used in medicine mostly in the form of preparations of its rhizome or root. Lewin and Guillery report at least one case in which a dose of 12 grams of the alcoholic extract produced vertigo, headache, a feeling of anxiety, weakness of the heartbeat, and marked "congestion of the eyes."

Cina. A term for santonin.

Cinaedus. (L.) A certain bird whose bile was recommended by Galen for the removal of superfluous hairs about the eyes.

Cinchona, Amblyopia from. While amblyopia and amaurosis of a more or less well-defined type may follow the ingestion of almost any of the thirty-five alkaloids found in cinchona bark, yet, as is well known, it is mainly quinine that produces the loss of vision. The classic description early given by Knapp (*Bericht d. Ophthal. Gesellsch.*, 1881, p. 100) still holds true. He stated the symptoms as follows: "Marked pallor, general weakness, twitching of the mouth and extremities, *total blindness,* and deafness associated with loud *tinnitus aurium.* The pupils are widely dilated and do not react to light, but may to accommodation. The patient often loses consciousness to a greater or less degree, and it may be that the blindness and deafness are not noticed for several days because of the mental condition present. The ophthalmoscope shows an absolute anemia of the optic nerve and retina. The papilla is chalky-white and no trace of a blood vessel in that or the retina is to be seen. This state of things is to be seen in every case." See **Quinine amblyopia** and the major heading, **Toxic amblyopia.**

The use of the cinchona alkaloids in local anesthesia, although it has but an indirect interest to the ophthalmic surgeon, should not be forgotten. Ginsberg (*Berlin. klin. Wochenschr.*, Nov. 11, 1912) gives an account of the effect of these derivatives on the cornea, but it is not at all likely that they will displace, for the purposes of the ophthalmologist, such agents as cocain, novocain and similar anesthetics.

Cinchonidin. This is one of the numerous alkaloids obtained from certain varieties of cinchona bark. It occurs as white prisms or powder with a very bitter taste, and is used like quinine in 15 to 30 grain doses. It produces, in large doses, an amblyopia exactly like that of quinine. See Lewin (*Die Nebenwirkung der Arzneimitteln,* 1899, p. 434).

Cinchonine. This alkaloid is a derivative of cinchona bark and in the form of the sulphate is employed as a substitute for quinine sulphate. It occurs as white, shiny, bitter-tasting crystals. There are no accounts of decided amaurosis caused by this remedy, although paresis of accommodation has been observed by several writers—especially by Tuczek (*Berlin. klin. Wochensch.,* 1899, p. 374).

Cinematograph. MOVING PICTURES. The asthenopia, mostly in the form of "panorama" symptoms, produced by the efforts of the eyes to fix and interpret the swiftly-moving images of the cinematograph, particularly when the films are defective, has been a subject of comment both by ophthalmologists and the laity since the introduction of these pictures. Gould (*Journ. Am. Med. Assocn.,* Dec. 21, 1912, p. 2254) was among the first to write on the subject, and drew attention to a number of acute reflex disorders induced by attendance on this form of entertainment. The Superintendent of Public Schools in Chicago requested (1913) that the City Council pass an ordinance based on the Massachusetts law requiring a five-minute intermission between reels, so as to mitigate the eye-strain of the motion picture.

Etienne Ginestous (*Anales de Oftalmologia,* September, 1911) believes that what he calls cinematophthalmias result from ocular fatigue. Regarding the elements in cinematograph exhibitions which favor the development of such fatigue he suggests that original negatives may have poor definition, which will be greatly accentuated in the enormous magnification (sometimes as high as 300 diameters) of the positives. Again, the principle on which the cinematograph produces its illusion of uninterrupted movement is that of persistence of the retinal impression resulting from each individual film. Since, as Charpentier has shown, the persistence of a luminous impression varies inversely as the size of the retinal image, the seats nearer to a cinematographic screen are less desirable than those more remote. Excessive or insufficient luminosity may also cause fatigue. In order to obtain the regular alternation of image and eclipses the edge of the film is perforated by equidistant openings, by means of which the film is intermittently detained upon corresponding teeth. In the course of time, however, these openings become defective, the result being unsteadiness of the images, and oculomuscular strain.

Griffin Lewis (*Crouse-Irving Hosp. Bull.,* Feb., 1914) says that in Syracuse alone there are fifty-three licensed picture theaters with an estimated average daily attendance of forty thousand people, over one-quarter of the city's population, no small percentage of whom are children. Apparently not even members of the medical profession and the public health officials have realized the important part they play in the welfare of the community from a health standpoint. Many of these theater buildings are nothing but remodeled store rooms with no facilities whatever for ventilation. The air is breathed over and over and plenty of opportunity is afforded for contact between the infected and the non-infected, thereby facilitating the distribution of infectious diseases.

That the "movies" are a prolific source of eye-strain must have been recognized by many ophthalmologists, yet, with one or two exceptions, the attention of the public has not been directed to this important fact and, strange as it may seem, the victims themselves seldom suspect the cause of their trouble although many of them suffer from an exacerbation of the symptoms even while witnessing the pictures. These symptoms may vary in different individuals, but usually consist of one or more of the following, viz.: headache, vertigo, nausea and ocular fatigue followed later by vomiting, sleeplessness, lack of energy, etc. People with uncorrected refractive errors are the ones who suffer the most, although many with normal refraction may be affected to a certain extent if they patronize the "movies" too frequently or sit too close to the screen.

So far as endurance goes, each individual is a law unto himself, but sooner or later the excessive and continued adjustment of the intrinsic and extrinsic muscles of the eye bring about severe reflex symptoms.

The writer has discovered by personal investigation that there is a great difference in the amount of ocular strain produced at the various picture theaters. This depends upon several conditions, such for instance as the amount and quality of the illumination, the quality of the screen used, the interval between the reels, the relation of the seats to the screen and, last, but by no means least, the condition of the films and the manipulation of the machine. If the apparatus or its manipulation be poor, if the films are scratched from careless handling or long use, or if the sprocket holes of the reel are worn, a flickering or tremulous movement results with an inaccurate sequence or improper continuity of the individual exposures, thus producing retinal and muscular over-exertion.

When we consider that in the United States alone there are (1914) over twenty-five thousand moving picture theaters at which there is an average attendance of over fifteen million spectators, we may form an idea of the consequent amount of suffering brought about by this one cause alone. The source of this variety of brain-fag may be largely removed by wearing proper glasses to correct the refractive and muscular errors; by patronizing only those places which have good films, proper manipulation of same and proper intervals of rest between the reels; by sitting at the proper distance from the screen (no closer than forty feet) and, lastly, by not overdoing the attendance upon these places of amusement.

This much we can do for ourselves, and the Department of Public Safety can do much more by permitting licenses to be issued only to those proprietors of moving picture theaters who are willing to abide by the following rules. The writer suggests that we first install the proper mechanism which is operated by a motor instead of by hand, has an adjustable take-up or speed regulator and an automatic fire-shutter which renders more accurate the sequence of the individual images. Second: Illuminate only with the arc light of the direct current which is brighter and steadier than that of the indirect current. Third: Have for the reception of the pictures a proper screen, which is free from disagreeable and harmful glare. The so-called "Mirror screen," consisting of a mirror glass with a frosted surface, seems to be one of the most desirable. Fourth: Use no reels which have been in use over a month. Reels of an inferior quality or which from much use have been scratched, give poor definition or imperfections which will be much more apparent in the enormous magnification. Fifth: Allow at least three minutes intermission between each reel.

Cineraria maritima. SENECIO CINERARIA. DUSTY MILLER. RAGWORT. This well-known plant, whose tincture, fluid extract and fresh juice have for many years past been recommended as a local application for the cure of cataract of all kinds, cannot find a more appropriate place than among the list of quack remedies. Still, a few respectable names have been associated with its employment in that capacity and it only remains to be said that the instillation into the conjunctival sac of a preparation of this or any other member of the Senecio family has about as much effect upon the resolution or dispersal of opacities due to organic changes in the lens as pouring the same down the back of the patient's neck!

Within the last few months the Editor has received a pamphlet from a certain pharmacal company, lauding the many ophthalmic virtues of the plant and offering, in open defiance of the rules of Latin grammar, and at the modest sum of one dollar per vial, a preparation called Succus Cineraria Maritima. The circular states that "While its primary action is directed to capsular and lenticular cataracts, a number of ophthalmologists claim excellent results in other diseases of the eye. In iritis it overcomes the inflammations, removes adhesions, and causes rapid absorption of all exudates. After extraction of cataract by surgical means, Cineraria Maritima subdues the inflammatory conditions of the iris and ciliary body, which follow when the cortical substance of the lens remains in the anterior chamber. It promotes the ready absorption of non-organized opacities in the vitreous humor, especially when the consequence of recent infiltration. In cataract, Cineraria Maritima has rendered the use of the knife unnecessary, being curative whether the lens or its capsule, or both, are involved. It has a tendency to soften the opaque deposits, causing dissolution, and by its stimulating properties hastens absorption. In a short time the patient is enabled to distinguish objects readily, the tissues clarifying, the visual acuity becoming increased, and the sight restored.'' Would that all this were true!

Cinerescent. Of an ashy-grey color.

Cinesiology. The science of artificial or natural movements of the body or any part of it, employed as educational, therapeutic or hygienic agents.

Cinnamate of sodium. See **Hetol.**

Cinnamic acid. BETAPHENYLACRYLIC ACID. CINNAMYLIC ACID. CYNAMIC ACID. Under the foregoing synonyms this white, crystalline, odorless and volatile substance, obtained synthetically, or from the oil of cinnamon, balsam tolu, etc., is described as useful in tuberculosis, lupus, etc. It is occasionally employed as subconjunctival injections in 1 per cent strength, like its salt, *hetol.*

Cinnamon wood. See **Sassafras.**

Cinnamyl cocain. An alkaloid found in combination with cocain, the benzoyl group of which is replaced by the cinnamic acid radicle. The toxic symptoms following the use of impure cocain are probably due to the presence of this agent.

Cinnamyltropin. This is an aromatic ester of atropin (like salicyltropin) but it is not used in ophthalmic practice, and there are no authentic accounts of its action on the eye.

Cinquième paire. (F.) Fifth pair (of cranial nerves).

Cintré. (F) In the form of an arch.

Circinate retinitis. This rare form of retinitis was first accurately described by Fuchs in 1893, who observed it in 12 of 70,000 patients. It is characterized by the appearance, in the macular region, of a circular or oval zone of yellowish-white exudation, which, with indented edges and pigmented borders, often resembles a wreath.

Often the macula is diseased, showing irregular pigment patches resting on areas of yellow exudate. The retinal vessels pass over the circinate deposits. The remainder of the fundus is normal. Vision is gradually reduced in these cases, and the visual field is slowly limited. A central scotoma is present; the light-sense is unaltered; metamorphopsia, night-blindness, and day-blindness are absent. The disease is eminently chronic, and the ophthalmoscopic picture may remain unchanged for years. On the other hand, de Wecker has observed new hemorrhages with the formation of new white spots. In Friedenberg's case new vessels formed in the retina. De Wecker saw circinate retinitis in one eye and hemorrhagic retinitis in the other of an aged diabetic subject. Vitreous opacities of various sizes, retinal detachment, and thickening of the retina at the macular region have been observed in these cases.

The *etiology* of circinate retinitis is unknown. The disease seems, however, to depend on arterial sclerosis. Syphilis may be an etiologic factor. The age of the accurately recorded cases has varied from 6 to 77 years. The disease has been seen more often in women than in men. In 5 of the 12 cases observed by Fuchs the changes were symmetrical; in 7 only one eye was affected.

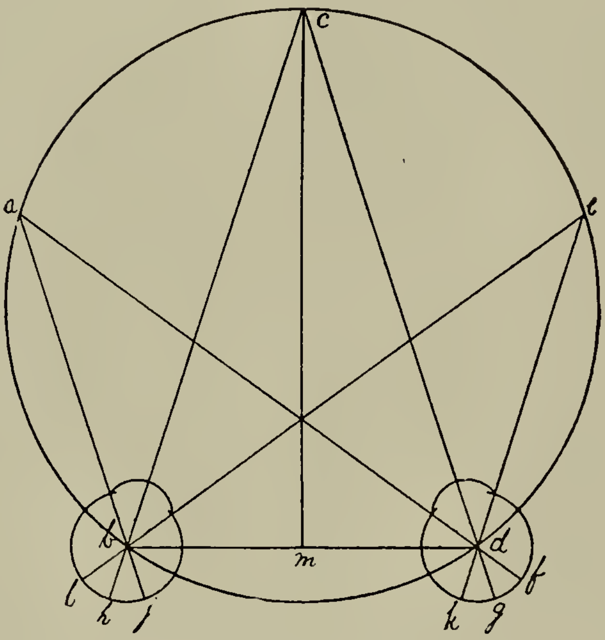
Fuchs regarded the white patches as fibrinous exudates into the deeper parts of the retina. De Wecker attributed the changes to fatty degeneration, the result of hemorrhages. Ammann, after having made the anatomic examination of an eye which at one time presented a typical picture of retinitis circinata, concluded that the white spots are brought about by fat-cell clusters sequent to hemorrhages.

The ophthalmoscopic picture is so typical that the *diagnosis* should not present much difficulty. However, de Wecker has called attention to the danger of mistaking this disease, when it occurs in children, for neuroepithelioma of the retina. He cites the case of a girl, 6 years of age, from whom a confrère removed an eye which for two years had presented lesions resembling neuroepithelioma of the retina. Examination showed the presence of plaques of atrophied chorioid and degenerated retina, as well as a small ossifying fibroma.

Although the disease is incurable, in none of the recorded cases has the patient become entirely blind.

In a few cases improvement has followed the use of mercury, the iodides, and iron preparations. Subconjunctival injections of sodium chlorid and pilocarpin have been advised.—(J. M. B.) See, also, **Retinitis circinata.**

Circle, Isogonal. The circle of binocular single vision for any given degree of convergence of the visual axes in the act of fixation, may be easily constructed. By reference to the accompanying cut it will be seen that the three points chosen for the construction of the circle are: *c,* the point of fixation of the two eyes; *b,* the center of retinal curvature of the left eye; and *d,* the center of retinal curvature of the right eye. This circle of single seeing is in the plane of the visual axes. A point situated anywhere on this line, capable of sending rays of light into the two eyes, must be seen as *one* by the two eyes. The visual axis, *h-c,* and the visual axis, *g-c,* intersect at *c;* therefore the point *c* must be seen as one, an image falling on the macula of each eye. Point *a* on the circle sends rays of light (not shown in the cut) into both eyes. Those in the right eye strike the retina at *f;* those in the left eye, at *j.* The visual line *a-f* passes through the point *d,* and the visual line *a-j* passes through the point *b.* It can be proved that *j* is just as far on the nasal side of the yellow spot *h* as *f* is on the temporal side of the yellow spot *g.* Since the angle *a-b-c* is equal to the angle *h-b-j,* and the angle *a-d-c* is equal to the angle *g-d-f,* it only remains to prove that the angle *a-b-c* is equal to the angle *a-d-c,* in order that it may be shown that *j* and *f* are corresponding points of the two retinas. The angle *a-b-c* (an inscribed angle) is measured by half the arc *a-c;* the angle *a-d-c* (an inscribed angle) is measured by half the arc *a-c.* Since the two angles *a-b-c* and *a-d-c* are each measured by half the same arc, *a-c,* the one must be equal to the other. In the same way it may be shown that the retinal points, *l* in the left eye and *k* in the right eye, are corresponding points. If the visual axes were rotated so as to have their point of intersection at *a,* the angle formed by these axes in the new position would not be changed; for in each of the two positions the angle would be measured by half the arc *b-d.* If the point of fixation were *e,* the angle formed by the visual axis would still be measured by half the arc *b-d,* hence would be the same as when the point of fixation was *c.* The same would be true of any point on the circle that could be fixed. It is interesting to note that all angles formed by the inter-section of visual lines at points on the circle would be equal, for they



Isogonal Circle. (Savage.)

all would be measured by half the same arc, *b-d*. Since two of the points (the centers of retinal curvature) through which the circle of binocular single seeing must pass, remain always the same, the size of the circle depends on the distance of the point of fixation. Whether the circle be large or small, points within it will be doubled, for the images cannot fall on corresponding retinal points, and points beyond the circle will be doubled for the same reason; and that, too, regardless of the point on the circle that may be fixed.—(G. C. S.)

Circle of curvature. The circle whose radius of curvature at any point of a curve is equal to that of the curve.

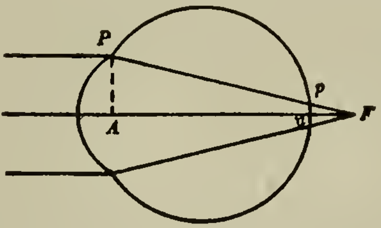
Circle of dissipation. The circle area upon the retina within which the image of a luminous point is formed.

Circle of least confusion. The nearest approach to a well-defined image of the point-source. See **Astigmatism.**

Circle of Zinn. CIRCLET OF ZINN. A synonym of the *circulus arteriosus nervi optici* (q. v.).

Circles of confusion. Same as *diffusion circles.* See **Circles of diffusion.**

Circles of diffusion. Circles due to an aberration of refrangibility of the rays of light as they pass through various lenses.



Diffusion Circles. (After Jackson.)

According to Edward Jackson (*System of Diseases of the Eye,* Vol. I. p. 489) the pencil of rays entering the eye from any luminous point is limited by the outline of the pupil, approximately circular. "If we suppose this circle to be situated in the second principal plane, the rays after leaving this plane occupy a cone with its base the pupil and its apex the focus towards which they tend. If at any point in front of or behind this focus the rays be intercepted by a plane parallel to the base, as by the retina, they will be found to occupy a circle the diameter of which is directly proportional to the diameter of the pupil and to the distance of the intercepting plane from the focus, and inversely proportional to the distance of the second principal plane from the focus. Thus, in the figure we have the similar triangles APF and apF, in which $AF : aF :: AP : ap$, or

$ap = \dfrac{AF}{AP \times aF}$. In calculating the size of diffusion circles formed on the retina, situated a known distance from the focus, one may, for all practical purposes, regard the plane of the pupil as coincident with the principal plane of Donders's reduced eye.''

Circles of dispersion. Figures produced by convergent or divergent rays upon the retina of an eye adjusted for parallel rays. In such an eye convergent rays would be brought to a focus in front of the retina, and divergent rays would be brought to a focus behind it. Whether the focus of the rays lies behind the retina or in front of it, each luminous point from the object is no longer represented by a point on the retina, but by a circle, and, as these circles overlap each other, the image is indistinct. The circles of dispersion take the form of the pupil.—(Wells.)

Circlet of Zinn. See **Circle of Zinn.**

Circoli di diffusione. (It.) Diffusion circles.

Circoli di dispersione. (It.) Circles of dispersion.

Circolo ciliare. (It.) Ciliary corona or circle.

Circonflexe. (F.) Circumflex.

Circular measure. See **Angular.**

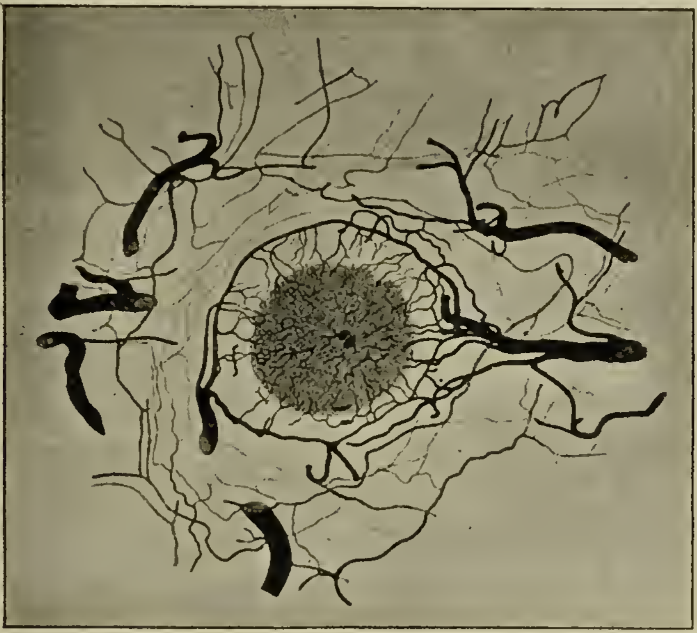
Circular polarization. CIRCULARLY POLARIZED LIGHTS. A condition in which the ether particles vibrate in a circular motion and in a direction transverse to that of the ray. See, also, **Polarization of light.**

Circular sinus. CANAL OF SCHLEMM. See page 1378, Vol. II, of this *Encyclopedia.*

Circulation of the intraocular fluids. The old-time theories of the secretion, circulation and exit of the various intraocular fluids are, like other physiological and pathological questions relating to the human body, constantly undergoing changes of front; not merely from decade to decade, but sometimes from year to year. The bearing of these questions not only on the ordinary functions of the eye but upon pathological processes, such as the rise and fall of ocular tension, the production of glaucoma, the formation of cataract, etc., are very real and very practical.

So far as the *intra-ocular blood circulation* is concerned, it has been discussed on page 617, Volume I, as well as on page 1228, Volume II, of this *Encyclopedia.* That a better idea may be given of the important vascular area about the optic nerve, to which reference is made in this section, an illustration is here introduced into the text.

Behr (*Ophthalmology,* p. 630, July, 1912), after studying the question of lymphatic paths and currents in and about the optic nerve, by systematic injections into more than 40 human nerves has reached the following conclusions: The fluid secreted by the retina passes through the lamina cribrosa into the stem of the optic nerve and intermixes with that of the nerve. Through the subpial, subseptal and parenchymatous lacunæ it flows within the pial sheath of the nerve with the larger part of the fluid secreted in the perivascular system of the central vein. A communication of the lymphatic spaces of the nerve with the intervaginal space practically does not exist; only a small portion of fluid from the perivascular space goes into it. Within the cranial cavity the tissue fluid flows through the pia from the nerve into the subarachnoidal space of the brain and perhaps the third ventricle. The microscopical specimens made by Behr suggest an inner connection between the lymphatic canaliculi and the glia fibers of the nerve. The glia may have, besides its supporting function, an essential relation to the inner processes of nutrition of the nervous substance.



Circulus Arteriosus Nervi Optici or Circle of Zinn. (After Leber.)
Optic nerve and sclerotic injected, retina and choroid removed; arteries black. veins paler. The central artery and vein of the retina are seen in the section in the centre of the nerve; at the periphery are several large short posterior ciliary vessels; surrounding the nerve is the circle of Zinn. Note the relative size of the short posterior ciliary arteries and veins.

The student of the *intraocular lymph circulation* and such related matters as the intra- and extra-ocular pressure—especially the general blood pressure—may read with much benefit those excellent chapters on the *Circulation of the Eye* in Parsons' *Pathology of the Eye,* from which the following paragraphs are quoted:

This classic review of the whole subject may well be read in its entirety as a complete account of the experiments performed and of the various theories and hypotheses brought forward from time to time to support or controvert opinions more or less strongly held by one observer or the other.

The chief objection to most of the experimentation done in connection with these problems—as well as with other questions in human physiology—is in the use of lower animals whose organs are not identical with those of man. The results of experiments on guinea pigs, rabbits, dogs, frogs, and other species of the amphibian and lower vertebrate type can be *suggestive* only of probable human functional and pathological activities; it is not too much to ask that they be carried out on monkeys—preferably the higher apes—so as to realize the human condition as near as possible. The argument for the employment of organs whose tissues are humanly identical is all the stronger in that the results obtained by the use of amphibia and the inferior vertebrate are not merely negatively objectionable but they may be positively misleading. None who has read Wiedersheim's or Franz's works on the comparative anatomy and physiology of the eye—not to mention the comparative studies so carefully abstracted in this work of Parsons—can fail to realize that the histological and morphological characters of the material generally employed in deciding questions in human physiology forbid the drawing of definite conclusions from these alien premises.

"There are no typical lymphatic vessels within the eye; these only occur in the conjunctiva. Some of the vessels which perforate the sclerotic and some of those within the eye, *e. g.* the retinal vessels. possess perivascular adventitial lymph-spaces; otherwise the lymph is contained in intercellular spaces and clefts, or in larger lymph-reservoirs. The most important of the latter are the anterior and posterior chambers, the spaces of the zonule of Zinn, the central canal of the vitreous or Cloquet's canal, the perichoroidal space, Tenon's capsule. and the intervaginal space of the optic nerve. The intra-ocular lymph-spaces may be regarded as extensions of the intra-cranial lymphatic system, the subarachnoid space being continued forwards, little changed in the optic nerve, then reduced to a potential space, the perichoroidal. and finally expanded into a large reservoir, the anterior chamber. the ligamentum pectinatum of which shows a marked resemblance to the subarachnoid meshwork. (Leber).

There is no direct communication between the anterior chamber and the canal of Schlemm, as was at one time held by Schwalbe. neither are there any lymphatic vessels draining the anterior chamber.

Thus, if colored solutions are injected into the anterior chamber, they pass out solely by way of the anterior ciliary veins. If the blood-vessels are previously filled with a gelatine mass, so that this means of exit is cut off, injection of solutions into the anterior chamber still fails to reveal lymph-vessels. According to Schwalbe the anterior ciliary veins have no perivascular lymph-spaces.

Injections of India ink, etc., into the anterior chamber pass also into the posterior chamber and into the canal of Petit, which is proved by these and other experiments not to be a closed canal, but merely a system of spaces between the fibres of the suspensory ligament. The mass also passes for a short distance behind the lens, but is prevented from passing completely round it by the firm adhesion of the lens to the patellar fossa. In the case of India ink, some of the particles are found in the vitreous, and, indeed, become so closely aggregated upon the very delicate hyaloid membrane that it appears uniformly black: later the particles become diffused between the vitreous fibrillæ. (Leber.)

The *hyaloid membrane,* separating the canal of Petit from the vitreous, *is readily permeable to fluids by filtration.* From the vitreous fluid passes into the canal of Cloquet or Stilling, and thence by very fine perivascular lymph-spaces round the central vessels to the intervaginal space. The central canal of the vitreous can be demonstrated by dropping colored fluid upon the posterior triangular expansion (Stilling), by injection of Berlin blue or alkannin turpentine under the pial sheath of the nerve (Schwalbe), or into the axis of the nerve near the central vessels (Leber). In some cases it becomes marked out with India ink after injection of the posterior chamber (Leber).

The *perichoroidal space* stretches from near the insertion of the ciliary muscle to 4 or 5 mm. from the optic-nerve entrance—*i. e.*, to the zone in which the posterior ciliary vessels and nerves perforate. It is normally a capillary space, lined with endothelium, and is in direct communication with the lymph-spaces in the choroid (Sattler). The veins only of the choroid are surrounded by perivascular lymph-spaces, and these give exit to the fluid in the spaces between the arteries and capillaries, but not to that in the larger lymph-spaces of the choroid (Sattler). The fluid is carried away from the perichoroidal space by the perivascular lymph-sheaths of the emissaries of the vortex veins, thus communicating with Tenon's capsule. This fact is easily proved by injection of the perichoroidal space (Schwalbe). Anatomically only the inner third of the vortex veins, as they pass through the sclerotic, possess a definite perivascular space, and this is traversed by fibres, which form a kind of mesentery. The same structure is found around the long and short posterior ciliary arteries and the anterior ciliary arteries and veins (Fuchs), so that all probably possess functional, though somewhat atypical, lymph-sheaths (Schwalbe).

The retinal vessels, like those of the brain, are surrounded by perivascular lymph-sheaths. This was first proved by His; by forced injection of the vessels, some of them burst in places, allowing the mass to flow into the sheaths. His succeeded in injecting both vessels and sheaths by different colored masses. It is doubtful whether the arteries possess perivascular sheaths; they are certainly more difficult to demonstrate. The spaces may also be injected from beneath the inner sheath of the optic nerve (Schwalbe), and the mass then passes out into ray-like clefts in the nerve-fibre layer and between the vitreous and internal limiting membrane, or even into the central canal. The subarachnoid space is easily injected from the same space around the brain, and it is also in free communication with the subdural space. These, again, communicate by way of the perivascular spaces of the dural sheath with the orbital lymphatics and Tenon's capsule. According to v. Michel the perichoroidal space communicates with the subarachnoid around the optic nerve, but this is not the case in lower animals (Schwalbe). The lymph-spaces of the optic nerve cannot be injected from the intervaginal space. They are readily demonstrated by injection beneath the pial sheath, the mass flowing between the bundles of nerve-fibres, or even around the individual fibres, according to the pressure of injection. The intra-neural lymphatic system is particularly well-developed in the lamina cribrosa. The conjunctiva possesses a superficial and a deep network of lymphatic vessels, and these communicate with each other by short anastomoses. They can be injected either from beneath the conjunctiva or from the cornea. In both cases it is best not to use a watery solution, which causes much swelling and distortion; alkannin turpentine (Leber) and asphalt benzol (Klein) are recommended. The superficial plexus consists of fine, uniform vessels, the deep of coarser, irregular vessels with more valves. There is a very fine network at the limbus. The larger peripheral vessels run parallel to the blood-vessels to the inner and outer angles. Where there are follicles, as in lower animals, these are surrounded by a dense network. The tarsal plexus is finer than that of the fornices; it communicates with the pretarsal system chiefly at the lid margin, there being few anastomotic vessels passing through the tarsus. Injection of the cornea demonstrates two kinds of spaces: (1) Bowman's corneal tubes, long spindle-shaped spaces, due to separation of the lamellæ, best shown by injection of air or mercury; these are undoubtedly artefacts; (2) spaces taking the shape and arrangement of the fixed corpuscles and nerves. Both are usually seen in the same preparation, the first best in the ox, the second in the rabbit (Leber). It is probable that the perineural spaces are true lymph-spaces. According to Leber there are no true lymph-spaces in the cornea, the fluid circulating by diffusion.

"*The normal aqueous.*—The anterior and posterior chambers contain 0.23-0.4 c. c. of aqueous (see **Aqueous humor**); it has a specific gravity of 1008-1009 in lower animals, but only about 1004 in man. It is a clear, alkaline fluid, containing about 1 per cent. of solids. Kletzinsky found 0.045 per cent. of proteids; Wessely in rabbits, by an optical method of estimation, 0.02 per cent.; the percentage is therefore extremely low. The proteids are serum albumin and serum globulin. Normal aqueous does not undergo spontaneous coagulation; it contains neither fibrinogen nor fibrin ferment (Jesner).

The aqueous contains traces of grape-sugar (0.045 to 0.05 per cent.); this has been put beyond dispute by the demonstration of the osazon (Pautz). The amount is generally, but not invariably, increased in diabetes. Normal aqueous also contains a diastatic ferment, as is shown by digestion with starch solution (Leber). It contains traces of paralactic acid and urea. The inorganic constituents amount to 0.8 to 0.9 per cent. in oxen, but only 0.58 to 0.64 per cent. in man (Kletzinsky); most of this is sodium chloride—about 0.7 per cent. (Lohmeyer, Cahn), 0.48 to 0.53 per cent. (Kletzinsky). The aqueous which is secreted immediately after emptying the anterior chamber by a puncture or paracentesis differs from normal aqueous in being spontaneously coagulable, and in containing a greatly increased amount of proteid. Up to three and a half hours the fluid is replaced by a dense coagulum on heating or addition of nitric acid. In the rabbit the fluid does not coagulate spontaneously after four hours, but the normal proportion of proteid is found only after six to eight hours (Bauer). Leber was unable to find leucocytes in the interval from half to twelve hours after paracentesis."

"The fibrillar tissue of the *vitreous* obtained by mincing it up and filtering off the contained fluid, is a collagenous substance yielding glutin on heating for five hours at a temperature of 105° to 108°. The fluid is almost identical with aqueous; the specific gravity in the ox is about 1007, in man 1008.9. The proteids, serum albumin and serum globulin, are present in small quantities as in the aqueous; estimations differ, partly owing to the method employed, mucin being precipitated and reckoned in by some of the methods, partly owing to differences, according to the part of the vitreous investigated (Leber). A mucinous substance was described by Virchow and confirmed by

Portes, Boë, and Mörner, who called it 'hyalomucoid.' It is not easily demonstrated by the usual acetic acid test owing to the large amount of salts present, but is precipitated on dilution with 2 to 3 volumes of water and addition of acetic acid up to 1 per cent. That it is a true mucin is proved by the liberation of a reducing substance on warming with dilute acids. The quantity is not more than 0.1 per cent. (Mörner). Traces are said to be present in aqueous (Mörner), but this is doubtful (Leber). It is possible that the mucin in the vitreous is derived from ameboid cells (Iwanoff).

"Sugar is present (Jesner), a fact placed beyond dispute by the demonstration of the dextrosazon (Pautz); urea can also be easily demonstrated. Paralactic is shown by Uffelmann's reaction, and by other more delicate tests (Pautz). As in the aqueous, there is also a diastatic ferment (Lépine); it is possible that this is due to bacterial contamination (Leber) and Lépine finds that it is not present immediately after death, a fact which he considers due to a non-active precursor or mother-substance. There is no spontaneous coagulation, so that fibrin ferment is probably absent. The inorganic constituents amount to nearly 1 per cent., sodium chloride accounting for 0.77 per cent. (Lohmeyer). The proportions of other salts have already been given. The osmotic co-efficient is about the same as that of aqueous (Kunst):

	Vitreous. Per cent. NaCl.	Aqueous. Per cent. NaCl.
By the blood-corpuscle method...........	0.96	0.971
By the freezing-point method............	0.925	0.959

"The similarity of constitution of aqueous and vitreous is confirmed by the determination of the refractive index, both giving results nearly approximating 1.337."

"The *normal intraocular tension* is maintained by keeping the quantity of fluid within the globe constant. As the fluid is continually draining away slowly into the venous system a constant quantity can only be maintained by an equivalent slow renewal of fluid. Hovius (1702) first attempted to measure the amount of fluid which drained away when the anterior chamber was opened. Jesner found the amount in the rabbit to be 48 c. mm. per minute; since the volume of the rabbit's anterior chamber is about 300 c. mm. the chamber would be refilled in about six minutes. Leplat gives smaller values—7-20 c. mm., results probably vitiated by coagulation. If the drainage is measured against varying pressures it is reduced to *nil* when the pressure is equal to the normal intraocular pressure, as might be expected: the amount is inversely proportional, roughly speaking, to the adverse pressure. Hence it may be concluded that under normal circumstances the whole of the fluid secreted is absorbed into the blood circulation, and further, that the amount secreted cannot be estimated by the amount which will drain off through a cannula. That constant reabsorption of the fluid secreted is taking place is shown by the injection of an indifferent fluid into the anterior chamber of a freshly removed eye under constant pressure. If a horizontal glass tube containing an air-bubble is interposed between the reservoir of fluid and the eye, it will be seen that the air-bubble moves towards the eye. Moreover, the fluid, especially if it be colored, can be seen to exude from the cut ends of the anterior ciliary and vortex veins, and the pericorneal region becomes injected with the colored fluid (Priestley Smith). This method indicates the principles upon which the rate of secretion of the intra-ocular fluid can be measured. For accurate determinations it is necessary to use a specially arranged manometer; as the same arrangement is employed for measuring the intra-ocular pressure, the description of the instrument and its modifications will be considered under that heading. The experiments of Adamük, Jesner, and Niesnamoff show that the amount of fluid secreted is proportional to the difference in pressure within the blood-vessels and that within the eye, *i. e.,* outside the vessels. In other words, the secretion follows the physical laws of filtration and is not a true physiological 'secretion.' If the cannula of a filtration manometer is introduced into the eye the conditions vary according to the difference between the intra-ocular and manometric pressures. If these are the same no fluid enters or leaves the manometer. If the manometer fluid is at a higher pressure than in the eye fluid flows from the manometer into the eye. The quantity which enters the eye is less than that which enters the excised eye under similar conditions, because fluid is being secreted by the eye itself. Hence the difference between the amounts of fluid entering the living and the dead eye will give the amount of fluid secreted by the eye at the given pressure. If the pressure in the apparatus is less than that in the eye fluid will flow into the manometer. If the production of intra-ocular fluid is dependent on a process of filtration through the blood-vessels and the epithelium covering the ciliary processes, its rate must vary directly with the difference of pressure on the two sides of the filtering membrane. It must vary, therefore, directly with changes in the capillary blood-pressure. and inversely with the changes in the intra-ocular pressure.

"In every case [of experiments on dogs by Henderson and Starling] a *rise of intra-ocular pressure caused an increase in the amount of fluid secreted.* It is impossible, however, to deduce directly from these experiments that the intra-ocular fluid is a transudation. The opening of the eyeball and the consequent diminution of the intra-ocular pressure to zero have a serious effect on all the intra-ocular structures. Great dilatation of the vessels of the ciliary processes and iris is produced. The fluid, which, in the normal eye, is free from fibrinogen and contains the merest trace of proteid, rapidly acquires the power of coagulation, and its proteid content rises to 3, 4, or 5 per cent. The serious alteration of the vascular structures is shown in many cases by the appearance of red blood corpuscles in the fluid dropping from the cannula, and Greeff has shown that if the lowered pressure be brought about suddenly and maintained for some time, the epithelium covering the ciliary processes may be raised from the surrounding tissue so as to form small blisters, which are filled with coagulable lymph. It has been suggested by Greeff that the change in composition of the intra-ocular fluid ensuing on opening the eyeball is determined by the separation of the epithelium; but Bauer has shown that the proteid content may be raised in the absence of these epithelial changes, and that, on the other hand, the epithelial changes may be well marked on the subsequent day, when the wound in the cornea has closed, and the intra-ocular fluid has regained its normal composition. He also points out that the amount of change produced depends entirely upon the rapidity with which the intra-ocular pressure is lowered. The change in composition is probably due, as Leber suggests, to the great distension of the capillaries and the consequent separation of their epithelial cells. It represents, in fact, an alteration in permeability of the filtering membrane.

''It is important to get some idea of the amount of the intra-ocular fluid secreted under normal circumstances—that is, at normal intra-ocular pressure. Since the intra-ocular pressure is maintained constant so long as the blood-pressure is steady, the amount of fluid produced at a given intra-ocular pressure must be equal to the amount of fluid absorbed at the same pressure. It is, therefore, a matter of indifference whether the amount formed or the amount absorbed at any given pressure is measured.

''Leplat sought to abolish the absorption of the intra-ocular fluid by filling the anterior chamber with oil or vaseline. He arrived at the conclusion that the amount of fluid normally secreted by the ciliary processes is in the rabbit about 4 c. mm. per minute. In another set of experiments Henderson and Starling determined the rate of absorption of intra-ocular fluid at the normal intra-ocular pressure, and regarded this as representing the rate of production of this fluid under normal circumstances. The results of two such experiments show conclusively that the rate of absorption is determined, in the absence of disturbing factors which we shall have to consider later on, solely by the height of intra-ocular pressure.

"The *intra-ocular pressure varies directly as the blood-pressure in the vessels of the eyeball.* It must, therefore, be concluded that the rate of absorption of intra-ocular fluid is also determined by the height of the blood-pressure, and since the absorption must keep pace exactly with the formation of this fluid, it follows that the formation of the intra-ocular fluid must also be determined by the height of the intra-ocular blood-pressure. So far, then, the conditions laid down as necessary to be fulfilled in order to justify the filtration theory of the production of intra-ocular fluid have been fulfilled, and it might be conceded with Leber that the formation of this fluid is exactly analogous to that of lymph, and is determined by the difference of pressure between the blood in the vessels and the fluid outside the vessels. The observations of Henderson and Starling, therefore, tend to support in every particular the view laid down by Leber, namely that *the intra-ocular fluid is produced in the ciliary processes by a process of filtration, and that the sole factor determining the amount of transuded fluid is the difference of pressure between the blood in the capillaries and the fluid in the eyeball.*

"The intra-ocular lymph is secreted entirely, or almost entirely, by the ciliary processes. In lower animals, *e. g.*, the rabbit, in which the ciliary processes extend forwards on to the back of the iris this structure takes some part in the secretion, but in man little or none of the aqueous is derived from the back of the iris. That the ciliary processes are well adapted to secretory functions is shown by their anatomical peculiarities, especially in their very rich vascular supply and in the folds and depressions which so enormously increase their superficial area. That the iris has little to do with the secretion of lymph is shown by the cases of congenital aniridia, in which there is no lack of aqueous but even a tendency to glaucoma. If the evidence in favor of the secretory function of the ciliary processes be considered conclusive, there still remains the question of the exact mechanism of secretion. We have hitherto used the term 'secretion' in a general sense, prejudicing no special theory. In general physiology it is perhaps advisable to restrict the term to those cases in which fluid is produced, or can be produced, under conditions which are apparently contrary to ordinary physical laws. Thus, in the salivary glands saliva may be secreted against a pressure which far exceeds the blood-pressure in the carotid artery. It is obvious that this phenomenon cannot be explained upon the ordinary physical laws of filtration, though an increased knowledge of osmotic pressures may still reconcile it with physical processes of a different nature. Early observers, *e. g.*, Méry (1707), regarded the ciliary body as a whole as a gland, specially differentiated for the secretion of aqueous. More recently an attempt has been made to narrow down the glandular elements of the ciliary body to the epithelium. Treacher Collins regards the tubular outgrowths of epithelium in the pars plana as specific glands, specially concerned in the secretion of aqueous.

"The ciliary body as a whole in no way resembles a true gland, and the tubular depressions of the pars plana bear only a superficial similarity to true tubular glands elsewhere. On the other hand, the anatomical arrangements are exactly suited to the transudation of fluid by filtration, as is shown by the increase of superficial area by folding and reduplication, the extreme vascularity, etc. On the physiological side there is no porof of any true secretion; *i. e.*, no experiment has yet been devised proving the possibility of secretion of fluid by the ciliary body against a pressure greater than that of the local intra-vascular pressure. On the other hand, all the experimental evidence is consistent with a transudation of fluid by a simple process of filtration. The production of lymph in the eye therefore follows the laws of lymph-production in other parts of the body, where recent researches have tended to modify the conclusions of Heidenhain, which involved the assumption of a definite vital secretory process. The lymph which is secreted by the ciliary processes passes for the most part forwards from the posterior chamber through the pupil into the anterior chamber. None traverses the iris, as has been held by Ulrich and others. That the pressure of the iris on the lens produces some hinderance—a physiological seclusion of the pupil—to the passage of fluid must be admitted with Ulrich and Hamburger: it is, however, of slight moment. Ulrich based his views on experiments in which he injected potassium ferrocyanide into the vitreous: after enucleating and testing with ferric chloride, the ciliary margin of the iris was found to be deeply stained. There can be little doubt that this is due to diffusion, most marked here owing to the proximity of the ciliary processes (Leber). Koster has shown that the iris is impermeable to fluid by filtration under pressures of 5 to 10 mm. Hg. kept up for many hours, or of 20 mm. Hg. for at least a quarter of an hour. This is due, not to the resistance of the stroma, but of the retinal epithelium and smooth muscle. Leber has repeated Hamburger's experiment of injecting small quantities of reagent into the vitreous near the ciliary processes. With Chinese ink, in which case there is no question of diffusion, the particles appear in the pupil in eleven to thirteen minutes. Nuel and Benoît found that in man particles of ink appeared in the pupil after injection of one to two drops into the vitreous, an amount which could have no appreciable effect upon the pressure in the vitreous chamber. It may, therefore, be considered proved that under normal conditions all the fluid passing forwards from the ciliary body goes through the pupil.

"The *aqueous passes out of the anterior chamber by three routes:* (1) through the spaces of Fontana into the anterior ciliary veins by way of the canal of Schlemm; (2) through the anterior surface of the iris; (3) through the ciliary body, a small part of which, it must be remembered, enters into the boundaries of the chamber. It was formerly thought that the aqueous passed through the cornea. It was demonstrated by Leber that this was impossible under normal circumstances. He found that the living or fresh cornea is absolutely impervious to fluid by filtration until the pressure reaches 200 mm. Hg.—*i. e.,* about eight times the normal intra-ocular pressure, and probably four times the inter-capillary pressure. It is, therefore, impossible that fluid should pass through the cornea even under the highest tension found in glaucoma. Leber found that the *substantia propria* and Descemet's membrane were freely permeable, the former becoming cloudy when edematous. The protection to the passage of water into the cornea is therefore to be found in the endothelium lining the posterior surface. This is further proved by pathological and experimental observations, in which the endothelium is destroyed.

"The anatomical conditions at the angle of the anterior chamber are admirably adapted to filtration. The blood-vessels are reduced to mere endothelial tubes, and their walls are firmly adherent to the surrounding sclerotic, so that the lumen is kept constantly open. The close relationship of the insertion of the ciliary muscle may assist in this result during life, but experiments on the excised eye show that it is of subsidiary importance. Schwalbe first showed that the anterior ciliary veins were easily injected from the anterior chamber, and concluded that there was a free and open communication. This view was opposed by Leber, and the question was long a subject of dispute. The arguments brought forward by Leber were, however, incontestable, and Schwalbe finally admitted his conclusions. On the anatomical side it was shown that the anterior chamber could not be injected from the blood-vessels, which, on the theory of open communication, could only be explained by a system of valves, and no such valves can be demonstrated. Further, if there was an open communication, it would be impossible to understand how the tension could be kept raised for an indefinite time, or why, on emptying the anterior chamber, it does not immediately become filled with blood.

"If a solution of carmin is injected into the anterior chamber of a fresh eye under constant pressure, the episcleral venous network around the cornea after a short interval becomes filled with the colored fluid, which also runs out of the cut anterior ciliary veins. If there were an open communication between the anterior chamber and the veins the fluid would run out at once; though the interval is short—one or two minutes—it is sufficient to show that some process, such as filtration, is taking place. Moreover, the rapidity of outflow varies with the pressure of injection, and is more rapid the longer the experiment takes place after the death of the eye—*i. e.*, the greater the disorganisation of the endothelium of the vessels. Further, if the fluid contains suspended particles, these gradually block the tissue-spaces, impede filtration, and diminish the velocity of outflow. Most important is the apparently parallel relationship between the pressure and the amount of fluid excreted, a parallelism which can only be explained on the theory of a physical process of filtration.

"It is *à priori improbable that any excretion of fluid* from the anterior chamber *takes place through ordinary lymph-channels,* for it would be as difficult to conceive how the intra-ocular tension could then be maintained as on the theory of an open communication with the veins. Experimental investigation confirms the absence of this mode of outflow, for even if the vessels are filled with a gelatinising material, so that they are completely blocked, or if the veins are tied, no distension of lymph-vessels is seen and filtration is abolished.

"The part played by the iris and ciliary body in the excretion of aqueous is difficult to prove beyond dispute. In the dead eye after injection of carmin the colored fluid passes out, not only by the anterior ciliary veins, but also in smaller quantity and less constantly by the vortex veins. Experiments on the living eye long failed to adduce definite proof of absorption by the iris. The injection of diffusible substances is useless for the purpose, and injection of Indian ink, etc., is liable to set up fibrin formation in the anterior chamber, which leads to the abstraction of the particles of ink. Staderini and others concluded that absorption did not occur, whilst the researches of Brugsch and Tückermann, under Leber's supervision, failed to give uncontrovertible results. Leber and Bentzen's experiments on the dead eye with Berlin blue gave evidence of absorption by the anterior surface of the iris and ciliary body, and pointed to excretion by filtration into the veins rather than by lymph-channels. Nuel and Benoît and Asayama, by improved methods, using very small quantities of fluid, have succeeded in placing the matter beyond dispute. The former observers injected Indian ink into the vitreous in various animals, and in a few cases before enucleation in man, the eyes being removed from two and a half to six hours afterwards, when the ink had already passed into the anterior chamber. Asayama injected the fluid into the anterior chamber of rabbits, using special precautions against the loss of aqueous. Injection into the vitreous has the advantage that the hyaloid membrane and zonule filter off the larger particles, allowing only the very finest to pass forwards. It is found that the inky fluid is absorbed by the whole of the anterior surface of the iris, but especially at the situations where crypts are most numerous—*i. e.*, at the ciliary, and near the pupillary margins. The absence of endothelium here doubtless facilitates absorption, permitting the particles to penetrate deeply into the stroma, the first serious resistance to their further progress being caused by the smooth muscle anterior to the retinal epithelium. In man the ink is found especially aggregated around the vessels in the middle layer of the iris, forming black rings round the veins and capillaries, whilst the arteries remain free. In favorable cases the ink can be seen inside the smaller veins and capillaries. The ink also accumulates in the anterior part of the ciliary body close to the angle, and is continued as a black sheath in the adventitia of the veins. Asayama traced the particles in flat preparations along the affluents of the vortex veins in the anterior part of the choroid, and even in the lumen of the vortex vein as it traversed the sclerotic. The excretion appears to take place therefore through the veins, and not by the perivascular channels. The preponderant part played by the canal of Schlemm as compared with the iris and ciliary body is open to no doubt. This is shown by the far greater ease with which the anterior ciliary veins become injected, by the failure of filtration when the pressure in the vitreous exceeds that in the anterior chamber, the iris still remaining available for excretion processes, and by the abolition of filtration in secondary glaucoma, when the angle is blocked. The outflow of fluid from the vitreous is slow under normal conditions, as is shown by the results of injection experiments with fluorescein, etc. Probably under these circumstances all the lymph passes out by means of the perivascular sheaths of the central retinal vessels. If the anterior chamber is opened there is no question that the fluid finds an easy path forwards. It was early shown that if an eye is hung up by the optic nerve after a paracentesis almost all the fluid in the vitreous drains away, and the globe becomes quite flaccid (Janin, 1788). There can be no doubt that the restoration of the anterior chamber during life is largely aided by fluid passing forwards from the vitreous (Deutschmann); the fact has, indeed, been proved by Leplat's experiments with potassium iodide and Ovio's with strychnin, where these reagents were injected into the vitreous; the new aqueous after paracentesis contained appreciable quantities of the substances, derived obviously from the vitreous.

"The perichoroidal space drains into the perivascular lymph-spaces around the vortex veins, as shown by Schwalbe (1868): he also showed that the injection mass sometimes passes along the posterior ciliary vessels, but that the intervaginal space of the optic nerve was never injected. v. Michel confirmed his observation that the perichoroidal space could be injected from Tenon's capsule when this itself was filled by injection into the subdural space of the brain, the mass flowing along the intervaginal space of the nerve; this only occurs in lower mammals—calf, sheep, pig, dog—not in man. Key and Retzius showed that in man the fluid passed from the intervaginal space into the perichoroidal space, and thence out into Tenon's capsule. Deutschmann asserts that once in a young rabbit, after injection of a few drops of Indian ink into the subdural space of the brain, he saw ophthalmoscopically the pigment pass from the edge of the disc into the perichoroidal space. Birnbacher and Czermak found that fluid injected into the perichoroidal space passes into the vortex veins, not into their perivascular sheaths. Leber, however, has fully confirmed the experiments of Schwalbe, which have further been supported by many other observers; it is, therefore, certain that *the main outflow from the perichoroidal space is by way of the perivascular sheaths of the vortex veins.* The lymph which passes by this route is small in quantity and is derived solely from the choroid and ciliary body, involving only the internal economy of these structures and having nothing to do with the maintenance of the intra-ocular pressure."

Quite recently J. Kuschel (*Annals of Ophthalmology*, April, 1913, p. 227, translated by T. T. Blaise) has not only restated the various theories and hypotheses of the intraocular circulation but advances some novel opinions of his own, opinions which may be said to form another aspect of the whole matter, which in its turn will very likely —and probably in a short time—be amended or discarded entirely.

The structural material of the ocular envelopes in whose arrangement the desired architecture is recognized, consists almost exclusively of highly elastic tissue. The accompanying pressure is also known, residing, as it does, in the intraocular pressure of the tissue fluids, which is ultimately traced to the contractile force of the heart muscles. The power of the heart muscles and the resisting power of the elastic tissues act as antagonists, and together constitute the fluid pressure or turgor of the organs, and so likewise of the eyes. This reciprocal interaction between the two forces presupposes their similarity of action. This is in fact the case, because both sources of power are inexhaustive and do not become fatigued, and it will be shown that there likewise exist correspondence in principles in the construction of the heart and the eye, and both, like the object and its image in the glass, harmonize symmetrically one with the other.

With regard to position and boundary, mass and density, direction and course of the several tissues, a marked diversity obtains between the external sclerocorneal tissues and all the internal tissues. The former is amply designed for the purpose of being the sole supporter of the intraocular fluid pressure, and serves besides as a firm skeleton for the external and internal ocular muscles and also the more delicate internal tissues. On the other hand, the fluid pressure within the eye is regarded as a sequence to a fluid current, determined according to hydrostatic laws. We may then announce our hydromechanic conception of the eye in a general formula as follows: ''The eye is an almost spherical, elastic capsule entirely filled with a moving fluid, the greater part of the interior containing a weak obstruction to the current.''

Above all the eye is not, as is proposed by the experimental investigations that neglect the existence of the tissues of the vitreous body, a simple capsule filled with fluid, the hydrostatic pressure of which may be determined scientifically with the manometer.

The teachings of Leber regarding the fluid pressure, which are based thereon, seem fundamentally wrong and lead to erroneous conclusions. The ingress and egress is effected, in the main at least, by filtration—the ingress through the walls of the capillaries of the choroid, the retina and the ciliary processes; the egress into the veins of the canals of Schlemm. The remaining channels of exit at the optic nerve and along the vortex veins (venæ vorticosæ) have not with certainty been determined, and on account of their inferior efficiency can at most be viewed only as accessory exits.

The filtration surfaces of the inflow are obviously larger than those of the outflow. If instead of the filtration process we substitute the simple process of a current passage through tubes, then we may complete the above formula and state: The eye represents a spheroidal expansion of a tubular channel, of which the ingress tubes are decidedly larger than the egress tubes. On the basis of the laws governing currents in tubes, we arrive at the following conclusions: 1. The current speed within the eye is low. 2. The intraocular pressure is very high. 3. The intraocular pressure as lateral pressure upon the wall of the bulb must decrease in the direction of the current course.

If now the eye is constructed with the use of the least amount of material, *i. e.,* according to the principle of purposeful adaptation, then, in conformity with the above mentioned principles of adaptation, the eye must present the following form:

1. Since, in consequence of the reduced current speed, the conditions approach those of a bladder filled with a motionless fluid, it necessarily must assume approximately the shape of a sphere, but not entirely so.

2. In accordance with the internal pressure, its density as also its thickness must be quite considerable.

3. This must decrease in strength and resistance in the direction of the current.

Anatomic investigation teaches that all of these three conditions obtain in the sclerocorneal capsule.

The latter decreases in strength and resistance postero-anteriorly, indicating thus that the fluid current must flow in the same direction.

The *points of entrance and exit of the intraocular fluids* are located in distinct harmony with each other. Posteriorly are found the more copious sources, the blood vessels of the choroid and the retina, and anteriorly, at the angle of the anterior chamber, the comparatively smaller area of exit is located. Even the ciliary source of fluid is located up stream.

The mechanical construction of the interior of the eye is as follows: In the middle point of this part of the architecture, which is enclosed by the wall of the bulb like the works of a watch in an outer capsule, is the retina, representing a column or pillar structure lying between the inner concave surface of the choroid and the outer globular surface of the vitreous. This pillar-form character of Müller's fibers is shown by (1) the form, (2) the radial arrangement, (3) the rigid construction, (4) the adjacent anchorage and stiffening. The construction also seems adaptive, since it insures the purpose of the organ of vision, *i. e.,* since it serves as a supporting and isolation apparatus for the nerve elements, and at the same time prevents compression of the retina, either from within or from without. The bilateral pressure upon the retina, caused by the pillar arrangement, is radial in direction, corresponding to the spherical surfaces bordering on it, acting from the side of the choroid centripetally, and from the vitreous body centrifugally. The retina accordingly seems a special framework which is amply adjusted to the accompanying centrifugal and centripetal stress. This applies also to the adjoining tissues.

The choroid is an erectile structure which seems to be adapted to exert a radial, centripetal pressure upon the outer surface of the retina. In the character of its construction it corresponds fully with this function, and may be viewed as a tri-dimensional framework intended for a fluctuating pressure in the sense mentioned.

Viewed as a single membrane under stress, there must exist active strains in the same manner as exist in a tensely filled rubber bladder and likewise in the sclerocorneal capsule, which strains may be divided into two components, the tangential and the radiocentripetal. They correspond to the special construction. We observe here two networks of blood vessels and of capillaries, one of which, the layer of the large vessels, lies exteriorly next to the wall of the bulb; the other, the capillary layer (choriocapillaris), lies interiorly, adjacent to the surface of the vitreous, while the layer of the medium sized vessels is located between the two, separating them. The two concentric networks present in general a meridional and equatorial arrangement of their constructive parts, in which the elements running in parallel direction multiply posteriorly. Consequently the network appears to become denser and finer meshed from before backwards. This arrangement fully corresponds with the special conditions of tension which we must assume in view of the mechanical conditions. Both networks are essentially constructed with regard to centripetal tensions. The centripetal tensions, being components of the choroid as a whole, are pressure tensions. The vessels of the middle layer seem to be formed in accordance therewith, because they have an arborescent form, although they are designated as terminals, and thus imitate the arrangement of pillars or columns with arms extended in all directions toward the inner network of the small vessels. The choroid corresponds herein essentially with the pillar system of the retina. One may designate both as bridge formations.

The middle portion of the smaller end arbors present a bayonet shaped, double-kinked course, the more so the farther they lie forward, the original and last parts being radial in direction, and the middle portion more tangential. The arrangement of the separate end arbors is usually of such character that the anterior portion of the stems of the posterior end arbors or their tangential middle sections extend over the posterior end portions of the intermediate section of the one nearest anteriorly, thus forming a cover, in the manner of roof tiling, which rests on the peripheral parts or origins, *i. e.*, on the roots of the end arbors; the apices are supported internally, and these, in turn, support in the form of pillars the inner capillary net of the choroid. In this manner a two story bridge is formed. Since this rests against the unyielding, adjacent wall of the bulb, the pressure can act only in the direction of the retina. This is especially aided by (1) The inherent tension of the tissues. (2) The force of pressure and impulse of the blood current within the vessels, viz., by way of an expansion of the bayoneted, S-shaped end arbors. (3) The pressure of the secreted tissue fluids in the interstices of the choroid.

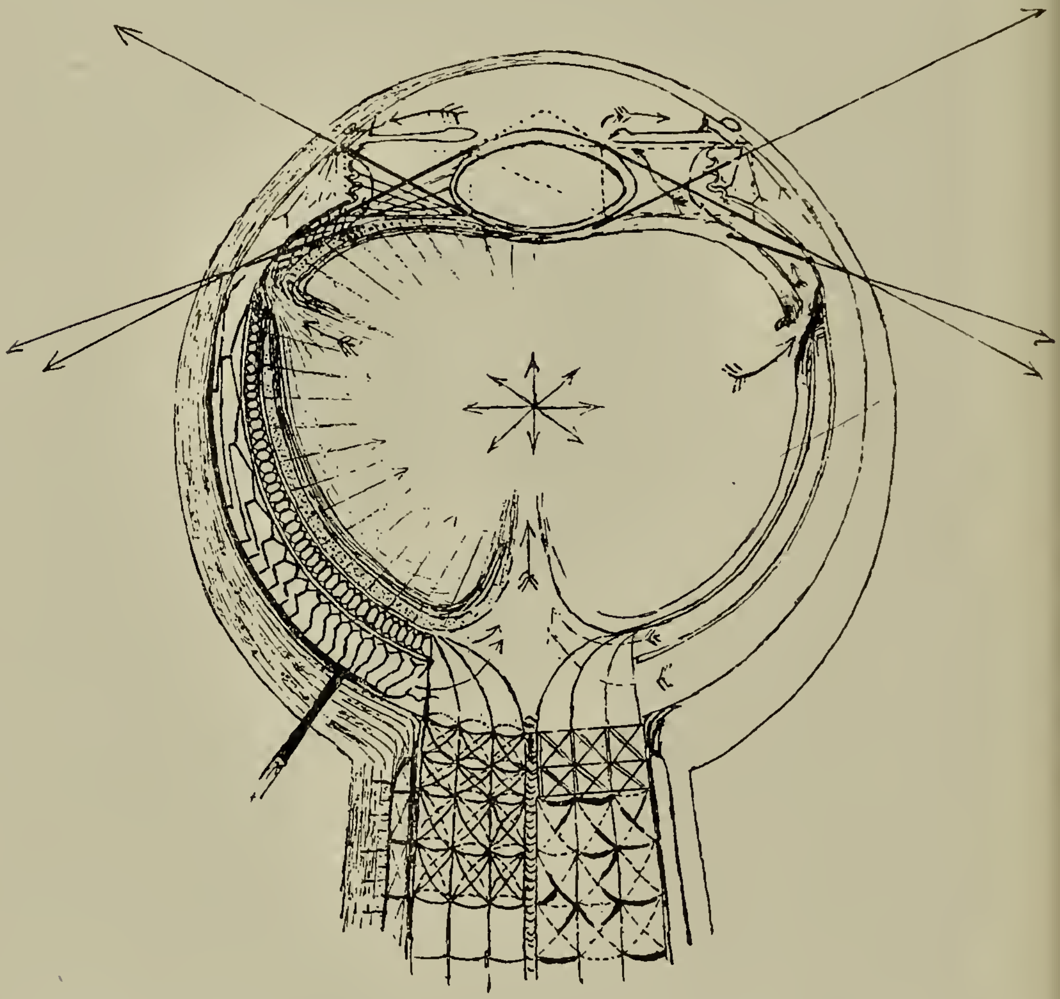


Diagram to Illustrate the Circulation of the Intraocular Fluids. (Kuschel.)

It is to be noted at this place, that the retina on both of its surfaces is isolated by elastic, homogeneous membranes, so that it is in direct combination with the choroid only at the entrance of the optic nerve, and further forward, towards the vitreous body, by means of the tissue meshes of the nerve head.

The inner pressure on the retinal pillars can come only from the vitreous body. The framework of this suggests the structure of an orange and represents a system of radial, meridional and equatorial tensions, the two latter forms increasing in number toward the circumference, and forming a dense texture of connective tissue fibers intersecting at right angles.

The limiting membrane of the vitreous body resembles in the arrangement of its constructive elements the structure of the choroid, as far as the two superficial, vascular networks are concerned, and the fiber intersections which have been demonstrated in the sclerotic portion of the bulb wall. We are therefore justified in claiming for the limiting membrane of the vitreous body the same mechanical function, which consists in propagating, by means of its components, the pressure on the walls centripetally. In the same way the tension will affect the radial fibers only, on account of their delicateness and pliability. Thus the total mechanical action of the vitreous structure would consist in the exertion of a centripetal pressure, and in the support as a vis a fronte of the pressure of the choroid displacing the retina centripetally.

The only pressure upon the retina from within in opposition to the choroid, is that of the fluid pressure of the vitreous body. The decreasing density and the rigidity of the pillars of the end arbors, passing from behind forwards, and the proportional decrease of the blood pressure in them, which as in manometer tubes indicates the lateral pressure in the ciliary arteries which run from behind forward, is proof of a concomitant decrease of the exterior pressure on the retina by the choroid, and indirectly of the inner pressure, which, as a reactive pressure, must correspond to this. Based upon this fact, we must acknowledge a vitreous current which passes from behind forward.

The zonula-lens system lies adjacent to the anterior surface of the vitreous body, and is under pressure on the one side from the vitreous, and on the other from the fluid in the anterior chamber. The former pressure is sustained by the zonula fibers which run from behind and laterally toward the anterior capsule of the lens, the latter by those zonula fibers which from before and laterally intersect the former fibers and pass to the posterior lens capsule. The fiber intersection gives the zonula-lens system the character of a framework bridge with diagonal bracing. The anterior lens capsule with its fibers is constructed stronger and has more resisting power than the posterior lens capsule with its fibers. If here again the principle of economy prevails, and if above all, under the presupposition of a fluctuating pressure, the maximum-minimum principle is solved, then the fluid pressure in the vitreous body is greater than in the anterior chamber. Herein also do we see evidence favoring the existence of a current in the vitreous which flows from the back part to the front and empties into the anterior chamber.

It has already been mentioned that the tissue spaces of the choroid are connected with those of the retina by means of the meshwork of the optic nerve head, while elsewhere on all sides the two are effectually separated by a homogeneous, dense, elastic membrane. A connection exists in the same manner farther forward toward the vitreous body. At the optic nerve head, beginning with a widened funnel shape, is the canal of Cloquet, passing into the interior of the vitreous body.

Anteriorly and laterally there is an interruption in the limiting membrane of the vitreous body at the so-called zonular fissure which leads into the depression between the ciliary process and is converted into a canal system by the over-roofing of the adjacent anterior limiting membrane of the vitreous. It leads via the posterior chamber and pupil into the anterior chamber. Thus the connection between the several current sections would be established.

The architecture of the eye, from the standpoint of statics, presents the properties of a framework equipped for the elements determining the character of the organ, the visual cells and their nerve conductions on the one hand, and the optic constituents on the other. The sclerocorneal capsule represents an external tissue skeleton, while the internal architecture presents the character of an internal skeleton.

All biometric constructions, however, are constructed with regard to a fluctuating strain followed by movements. We must therefore view the established architecture from the viewpoint of motility, *i. e.*, view it as a machine and attempt to explain it in accordance with the laws of dynamics.

The fluctuations of the intraocular fluid pressure which alone bear directly or indirectly on the question, have their prime origin in the motions of the entire body,—or in those of the eye itself,—since these produce on their own part wave motions and rotatory motions in the vitreous body (Best). Fluctuations of the intraocular pressure are also conditioned by the changing strength of the ingress and egress of the blood supply. Even the individual pulse waves, the active and passive hyperemias, as far as they are based upon the body circulation, and above all the so-called occupational hyperemia which must affect the activity of the organ of vision, all have their bearing.

Fluctuations of the intraocular pressure must naturally interact with the movement changes of the intraocular fluid currents, which meet with obstructions in the tissues traversed and are thereby rendered ineffective. This is essentially the case in the two groups of pressure fluctuations mentioned.

The sclerocorneal capsule is not very yielding, and for this reason behaves almost like a rigid, stable capsule. If it alone were concerned, the uneven current flow in the eye would behave similar to that inside of rigid walled tubes, *i. e.*, if a certain amount of fluid under a given pressure is forced in, an equal amount will flow from the other end, and the current will assume a jerky manner of sudden rise and fall of the fluid pressure. From the standpoint of adaptability to efficiency, such behavior could not serve the function of vision. It seems therefore reasonable that appropriate regulation should exist in the eye. The means which alone meet this purpose are the interposed obstructions, consisting of the internal tissue structures. They act (1) by means of obstructive friction solely; (2) by means of their elastic counteraction of the current, which seems particularly adequate on account of the peculiar character of its organized elasticity by which the contraction automatically increases in rapidity faster than the current pressure; (3) by means of the constructive arrangement, in the sense of the balancing of the pressure fluctuations and the uniform current.

Let us now imagine the entire fluid current as a tubular one; we have then a system of two symmetrically and contiguously arranged S-shaped tubes enclosed in an outer capsule. In the loop which is formed by the choroidal current with the vitreous current of the same side, lies the retina and its fluid current; in the loop which is formed by the last part of the vitreous body current with the ciliary section, the crystalline lens is located.

Based on this general foundation, we are enabled to deduce and elucidate by mechanical laws the peculiar character of the regulative apparatus presented to us by the architecture of the eye. In accordance therewith, an overbalancing of the outer pressure on the retina is effected by the increased blood supply, by increased filling of all the choroidal vessels, by a straightening of the kinked, bayonet-shaped stems of the end arbors, and by increase of the fluid pressure due to increased fluid production. In this way the choroid resembles an erectile body, which, because of its location against the inner side of the unyielding bulb wall, must tend to displace the retina in a centripetal direction. The bridge-like framework of the retina forms a relatively rigid structure, answering therefore the purpose of protecting the vision cells against pressure. The displacement of the retina as a whole toward the center of the vitreous body must be accompanied by symptoms of compression. The ensuing increased fluid pressure in the vitreous, acting in all directions, effects a closure of the funnel-shaped canal of Cloquet, which extends inward, and by pressure on the anterior limiting layer of the vitreous body and the contiguous zonula-lens system, it effects a distension of the zonular fissure, so that the two passageways in the vitreous circumference act like a pair of valves, which simultaneously permit a fluid displacement from the back forward. Consequently the fluid pressure is propagated anteriorly into the anterior chamber, so that an augmented filtration into the canal of Schlemm ensues.

The action of the choroid as an erectile body would accordingly consist of an acceleration of the fluid current outward. The obstructions consisting of the zonula-vitreous as well as the zonula-lens pressure, which resemble the tension of a spring, must be overcome.

With the gradual depletion of the vitreous body the pressure again drops and the action of the two valves reverses itself. The zonula pressure pushes the anterior limiting membrane of the vitreous body backwards in such manner as to close the cleft in the zonula. But the canal of Cloquet, on the contrary, is relieved from pressure and opens. The reaction upon the fluid current from this is as follows: The current of the choroid, checked during the closure of the canal of Cloquet, flows now freely without hindrance into the vitreous chamber, which in turn becomes again engorged on account of the closing of the anterior valve in the zonula fissure. During the decrease of the previously elevated pressure in the choroid, the fluid pressure in the vitreous body rises, and from this ensues a pressure upon the retina, directed outwards. Thus the vitreous body also represents an erectile body, it being suggestive of another erectile body, viz., the glans penis. When the pressure elevation of the vitreous body becomes active, the retina is displaced in a centrifugal direction and compresses the choroid against the scleral wall of the bulb. Since the resisting power of the choroid decreases from behind forward, and since the pressure of the vitreous body upon closure of the anterior valve represents that of a fluid body in a state of rest and is uniform on all sides, the choroid necessarily must become progressively compressed in successive steps from before backwards, by which the fluid current escapes posteriorly through the nerve head, and prior to the time of the flow into Cloquet's funnel receives the retinal current. The latter current, on account of the rigidity of the pillars of the retina, takes little or no part in these fluctuations, which, as far as concerns the function of vision, must be viewed as a purposeful adaptation.

Due to a corresponding elevation of the vitreous body pressure, this state finally reverses itself again on account of the forward push of the pressure of the zonula lens and vitreous body and the resulting opening of the zonular cleft. The condition then again is as it was in the beginning of the equilibrium disturbance, so that the procedure may start anew. If in the meantime no renewed wave of the blood current occurs in the choroid, after a briefer or longer balancing the tension of the inner architecture will again come to a state of rest, and a uniform current will be established. In any case, there will be a reduction of the intraocular pressure and its equalization.

The forces that operate in the mechanism are the contractile force of the heart muscles and the spring-like elasticity of the mechanical construction of the eye. They are related to each other like action and reaction; with this agrees the fact that during life neither ceases and their interaction continues without interruption. It is significant that both in the heart and in the eye the hydraulic principle of the mechanism of a pump is applied. The eye is the reflected image of the heart.

With the fluctuations of the tissue-fluid pressure in the choroid, there must necessarily ensue a fluctuation in the quantity of the filtration of the blood capillaries, since with a rise of fluid pressure a reduction of the filtration ensues, and upon lowering of pressure an increase follows. Based upon the fundamental, although little known, experimental labors of Landmann and Körner, I could more fully theoretically develop the existing relations. In accordance therewith, an adaptive antagonism between the choroid and the filtration of the ciliary body is established. During the excess of the vitreous body pressure, the filtration of the choroidal capillaries must obviously become reduced, and consequently there ensues an automatic self limitation of the inflow of fluids. In consequence of the simultaneous closure of the zonula valve, the pressure in the posterior and anterior chambers drops along the descent of the current, and the filtration from the ciliary region must correspondingly increase. This condition is then reversed when during the overbalancing of the choroidal pressure the valve conditions become reversed. This arrangement with regard to the uniformity of the currents suggests a practical adaptation to purpose.

To further complete the similarity between the mechanism here considered and that of a suction and pressure pump we have in addition the accommodation apparatus.

The ciliary muscle, as *tensor choroideæ,* effects a compression of the vitreous body and a widening of the choroidal current channel; by means of the release of the zonula-lens system, a relaxation and widening of the zonula cleft is effected. There occurs simultaneously, by means of traction on the inner wall of the canal of Schlemm, adjacent to which is the origin of the muscle's tendon, a widening of the lumen of Schlemm's canal, whereby the filtration from the angle of the chamber is facilitated. Thus we have by the contraction of the ciliary muscle during accommodation the same current condition with the same valve positions as we have by the entrance of a wave of blood into the eye, viz., in the choroid. During the state of rest of the accommodation the opposite naturally prevails. The alternate contraction of the accommodation muscles act therefore in a similar sense as the contractions of the muscles of the body in general, viz., with a view of conserving the purpose of currents. From this there appears still more clearly the similarity with the suction and force pump of the heart muscles. Earlier in the critical review of the experimental researches on the intraocular fluid currents, we observed that in the current system of the lens of the eye the principle of a suction and pressure pump also is applicable, by virtue of its relation to the accommodation. Thus the mechanical construction of the eye is a harmonious one. All parts are reciprocally conditioned and dovetail into each other, always with a purpose, which purpose in case of the eye can be only the conservation of the functions of the retina and the optical apparatus.

Another observer who, as Parsons states, disagrees with the teachings of Leber, is Hamburger (abstract in *Oph. Review* of Oct., 1910). *(Klin. Monatsbl. für Augenheilk.)* He believes that as a result of his experiments and also of those of Ehrlich with fluorescein, it is impossible to demonstrate either microscopically or macroscopically in the living uninjured eye any transudation from the ciliary body, but only from the anterior surface of the iris and that therefore the hypothesis of Leber and his school as to the method of secreting the intraocular fluid falls to the ground.

That this secretion from the anterior surface of the iris is probably, under normal conditions, immeasurably slow.

That the hypothesis of a free circulation from behind the iris is untrue, and that there is really a physiological valve-like closure of the pupil.

That the quantitative value arrived at by Leber's methods for the absorption of intraocular fluid are far too high.

That the chief path of removal from the eye is not Schlemm's canal but the whole vascular network of the iris. The action of eserine on glaucoma is to be explained by the unfolding of the iris and not by the freeing of the angle of the anterior chamber; the reverse action of atropine in raising the pressure being explained in a similar way by the crowding up of the surface of the iris.

That excretion from the eye is not as hitherto believed a physical process of filtration of mathematical regularity but a simpler if much slower process of absorption.

That physiological aqueous is a very different fluid from that secreted after puncture and has little or nothing to do with the activity of the ciliary body.

That the aqueous secreted after puncture comes almost entirely from the ciliary body.

That the energy of the ciliary body is normally almost entirely a potential one, but under what conditions and how frequently this potential energy is converted into a kinetic one is as yet not understood. See, also, **Intraocular pressure.**

Circulatory system, Diseases of the. This subject is partially discussed under **Blood-pressure,** page 1227, Vol. II, of this *Encyclopedia;* **Arteriosclerosis ocular,** page 614, Vol. I; **Bright's disease, Ocular symptoms of,** page 1296, Vol. II; and under various other related headings.

Circulus arteriosus Halleri. (L.) CIRCLE OF HALLER. CIRCLE OF ZINN. A vascular plexus upon the surface of the sclerotic at the point of entrance of the optic nerve, formed by branches of the short ciliary arteries.

Circulus arteriosus iridis major. (L.) The arterial plexus that encircles the outer or peripheral zone of the iris. See **Histology of the eye.**

Circulus arteriosus iridis minor. (L.) The circular arterial plexus in the pupillary region of the iris. See **Histology of the eye**; also **Anatomy of the eye.**

Circulus arteriosus musculi ciliaris. (L.) A circular arrangement of the arterioles in the center of the ciliary muscle.

Circulus arteriosus nervi optici. (L.) The arterial plexus in the sclera about the entrance of the optic nerve. It is formed by branches of the short posterior ciliary arteries.

Circulus arteriosus Zinnii. (L.) Circle of Zinn or Haller.

Circulus choroideæ. (L.) Ciliary ligament.

Circulus ciliaris. (L.) Ciliary ligament.

Circulus gangliosus ciliaris. (L.) A circular nervous plexus within the ciliary muscle.

Circulus Mascagnii. (L.) A circular arrangement in the fœtus of small capillaries in the region of the zonula of Zinn.

Circulus Petiti. (L.) Canal of Petit.

Circulus Schlemmii. (L.) The circular canal of Schlemm.

Circulus venosus ciliaris. (L.) The canal of Schlemm.

Circulus venosus corneæ. (L.) Schlemm's canal.

Circulus venosus Hovii. (L.) A ring-like anastomosis of the venæ vorticosæ in the chorioid.

Circulus venosus iridis. (L.) One of the numerous names for the canal of Schlemm.

Circulus venosus orbiculi ciliaris. (L.) Canal of Fontana.

Circulus venosus Schlemmii. (L.) A name for the canal of Schlemm.

Circulus Zinnii. (L.) The zonula of Zinn.

Circumagentes. The oblique muscles of the eye.

Circumcising the cornea. The incision of the bulbar conjunctiva around the cornea, the first stage of an eyeball enucleation.

Circumcorneal. Around or about the cornea.

Circumcorneal congestion. Circumcorneal zone. Ciliary injection or congestion. In acute keratitis, iritis and other diseases of the uveal tract the cornea is generally encircled by a pinkish zone, which a magnifying glass resolves into a number of closely set, very fine capillaries—branches of the anterior ciliary arteries. This vascular ring varies in width from 2 to 4 mm., while the remainder of the globe retains its natural white color. The condition is commonly known as *circumcorneal or ciliary congestion.*

Circumferentor. A compass with diametrical sights, fixed by a ball-and-socket joint on to a tripod stand. The dial, usually of 6 in. diameter, is divided into degrees on its circumference, on which is read the angle made by the line of sight with the magnetic north. It is a trigonometrical or optical instrument used chiefly for mine-surveying.

Circumgyration. Vertigo.

Circumlental. Surrounding the lens.

Circumlental space. The region between the margin of the lens and the surrounding structures.

Circumocular. Surrounding the eye.

Circumorbital. Surrounding the orbit.

Circumpapillary atrophy. A synonym of annular posterior staphyloma, the choroidal atrophy which in high degrees of myopia sometimes entirely surrounds the nerve head.

Circumscribed scleritis. This is another name for the commoner form of the so-called episcleritis, which consists of a rather sharply defined elevation, or patch, on the surface of the eyeball, a few millimeters from the corneal edge and, as a rule, to the temporal side. See **Episcleritis.**

Cire. (F.) Wax.

Cireux. (F.) Waxy.

Cirrhosis of the liver, Ocular symptoms of. Genuine eye diseases associated with or dependent upon cirrhosis of the liver are rare. Landolt (*Archiv. f. Ophth.*, 18, 1, 1872) has described two cases of retinitis pigmentosa, which he believed to be due to this disease. Night-blindness, xerosis, iritis, and whitish exudates into the retina Purtscher attributed to bacterial action and to the solvent effect of biliary salts upon the visual purple.

Cirsaneurysma. (L.) Cirsoid aneurysm.

Cirsoblepharon. (L.) Obsolete. A varicose state of the eyelids.

Cirsoid aneurism. Formerly cirsophthalmia, an example of which E. W. Brewerton records (*Ophthalmic Review*, p. 127, April, 1911) in the case of a patient, æt. 32, who had an injury at 3. The scar had grown steadily until the frontal region, upper lid and the orbit were invaded by a large vascular growth. Vision was reduced to counting fingers; fundus was normal. Ligation of the external carotid artery was suggested.

Cirsophthalmia. (L.) VARICOSE OPHTHALMIA. This term was formerly applied to a highly engorged or varicose condition of the conjunctival blood-vessels in high grades of inflammation. It has also been used to describe an extensive corneal staphyloma in which the cornea and sclera become bluish and appear to be in a varicose condition. In general, any varicose state of the blood vessels of the eye.

Ciseau. (F.) Chisel.

Ciseaux. (F.) Scissors.

Ciseaux à cuillère. (F.) Scissors with blades curved on the flat.

Ciseaux à strabisme. (F.) Scissors for squint operations.

Ciseaux coudés. (F.) Scissors with blades at an angle with the handle.

Ciseaux droits. (F.) Straight scissors.

Ciseaux mousses. (F.) Scissors with rounded or blunt points.

Cisma. (L.) The *Cassia absus.* The powdered seeds (*semen cismæ*) of this plant were blown into the eye by the old Arabian physicians, for the relief and cure of ophthalmia.

Cispa. (It.) Blearedness; the condition of blear-eye.

Cissus heptaphylla. (L.) A species of plant indigenous to India, where it is made into a "ptisan" to be used in ophthalmic diseases.

Cisterna chiasmatis et laminæ cinereæ terminalis. (L.) That portion of the subarachnoid space that is situated between the optic chiasm and the rostrum of the corpus callosum.

Cisterna intercruralis superficialis. (L.) That portion of the subarachnoid space which is situated between the pons Varolii and the optic chiasm.

Cisterna laminæ cinereæ terminalis. (L.) A subarachnoid space corresponding to the region of the optic chiasm.

Cisti ateromatose. (It.) Atheromatous cysts.

Cisticerco nel corpo vitreo. (It.) Cysticercus in the vitreous.

Cisti dell'iride. (It.) Cysts of the iris.

Cistotomo. (It.) Cystotome.

Citrate of copper. See **Cuprocitrol.**

Citrine ointment. Ungt. hydrarg. nitratis. This valuable application is made by the action of nitric acid on mercury to which lard is gradually added. It is a yellow salve, occasionally applied to the lids, but only when further diluted with lard or a similar excipient.

Dilute ointment of the nitrate of mercury is official in the British codex, and is made from the stronger ointment which is diluted with four times its weight of soft paraffin.

Citron. (F.) Lemon.

Citronenöl. (G.) Essential oil of lemon.

Citron, Jus de. (F.) Lemon juice.

Citronné. (F.) Containing lemon.

Citrononessenz. (G.) Essence of lemon.

Cl. (F.) Symbol of chlorine.

Cladothrix dichomata. See **Cladothrix Fœrsteri.**

Cladothrix Fœrsteri. Streptothrix of Förster vel dichomata. In the lachrymal canaliculi, especially in the lower one, there is occasionally to be found fragmentary, fat-like or sandy concretions of yellow or yellowish-green color. Under the microscope one sees branching and spiral fungus threads and the like. Since the generic name Cladothrix stands for various plants quite different from the above mentioned fungus it is not appropriate for the latter. According to more recent investigations these concretions probably represent *Actinomyces.* See page 84, Vol. I, of this *Encyclopedia.*

Under the title *Cladothrix dichomata,* McFarland (*System of Diseases of the Eye,* Vol. 2, p. 527) describes this organism as occurring in the lachrymal canals in the form of small chalky masses, often the size of a pea, and consisting of what seems at first a mass of closely intertwined filaments with dichomatous branching. "Under a high power this is seen to be a false branching, the several elements being placed at an angle with each other, but separated by a clear space.

The isolated filaments or about 0.40 microns in thickness, and vary in length up to 40 microns. They are straight or sinuous, or even spiral, in character, and are not motile. The ordinary aniline dyes stain them with facility. The growth of this *cladothrix* on culture media is characteristic. In gelatin plates it slowly (in four or five days) forms small, yellowish colonies which are surrounded by a brownish discoloration of the medium. They are granular, and show numerous filaments which extend a short distance into the liquefying gelatin. This liquefaction takes place very slowly. The colonies gradually become covered with a fine, chalky, dust-like deposit. In the tube of gelatin a similar growth takes place. At first there is a thin, grayish skin formed upon the surface, with some few white colonies along the track of the inoculation needle. The gelatin is slowly liquefied and discolored. The growth itself becomes a whitish, flocculent mass, and sinks to the bottom of the dark-brown liquefied medium. In bouillon there are formed the same white, flocculent masses, the fluid remaining clear. On agar-agar the colonies are most characteristic. They are semi-transparent, yellowish, glistening, parchment-like, and round, are marked on the surface with concentric rings, and grow down into the medium. This gradually assumes the same dark-brown color as gelatin, and the growth becomes covered with the same chalky deposit. On potato there is a white, skin-like growth, which takes on the chalk-like material and grows down into the substance of the tuber. This chalky material the microscope shows to be made up of short rods and of cocci, which are probably the forms of resistance of this micro-organism.''

Clairvoyance. Literally, ''clear-sightedness'' or ''clear vision.'' The faculty attributed to persons in the mesmeric state, of seeing objects not present to the bodily senses, whereby the clairvoyant is enabled to describe events passing at a distance. The simple clairvoyance of the professional entertainer is easily effected with the assistance of a code of signals and a good memory; generally the subject is blindfolded on the stage, while a confederate, passing among the audience, holds up the objects offered to him, and requires them to be named.

Clamydozoa. Also spelled **chlamydozoa**; a name for the **trachoma** ''bodies'' of Prowazek, or ''trachoma granules,'' as Greeff prefers to call them.

Claquement des dents. (F.) Chattering of the teeth.

Clarke's rule for regulating by weight the dosage in children. If one hundred and fifty pounds be regarded as the weight of an average adult, this number is made the denominator of a fraction whose numerator is the weight of the child. Thus, the amount for a child of 50 pounds would be 50/150 or ⅓ of the adult dose.

Clarry sage. Salvia sclarea. The flowers are made into an infusion and used as a domestic remedy in various forms of "sore eyes."

Classification of ophthalmic instruments. As stated in Wood's *System of Ophthalmic Operations,* Vol. 1, p. 471, it is not only difficult to classify, but almost impossible to enumerate, the great variety of instruments and appliances employed in eye surgery. The reader will find the great majority of these—especially the most useful ones—pictured and commented on under appropriate headings in this *Encyclopedia.* Although it may with justice be said that even the best classification is none too good, one cannot avoid the conclusions of Landolt that the handle is the most important of all the parts common to ophthalmic instruments, and that a rational classification might be based upon the variations in that essential part of eye instruments. "It seems," says Landolt, "sometimes that the importance of the handle of instruments for our delicate operations has not been sufficiently appreciated. We may consider it from the point of material, form, dimensions, weight and surface. The handles of the instruments were formerly all of ivory.

Ivory is an ideal material for this use; it is not too heavy or too light, it is a poor conductor of heat, but its best quality is the character of its surface—it is not slippery, and yet adheres delicately to the fingers. We are thus able to manipulate the instrument with accuracy and lightness as well as security. But we have been educated in the science of asepsis, and the sterility of our instruments must be our first consideration. There is no doubt that the ivory handles, as the makers give them to us, do not bear well the high temperature required for sterilization. But in reality it is less the ivory, than the cement and resin which are used in fastening the blade to the handle, that give way under high temperature. The resin melts and the blade soon hangs loosely in the handle. If, however, we can discover a cement which is not spoiled by heat, or if the maker will take the trouble to fasten the blade with a screw in a metal matrix made secure in the handle, this invaluable material may still be made use of. Although ivory cracks and is spoiled after repeated exposure to 140 degrees C., it is able to stand several sterilizations, and the handle can then be changed, as ivory is not an expensive material.

Instead of trying to save ivory for us, the makers of instruments have substituted for it iron, steel, and aluminum. Our brothers in general surgery have accepted this change without a murmur. Of course, when the instrument is held by the whole hand, the material makes little difference, but with us, who must manipulate our instruments with lightness, the weight and surface of the handle is of capital importance. The handles of steel and iron are too heavy for our work, even the hollow ones as they are furnished; their weight and slippery surface makes us grip them with so much muscular effort that the delicacy of our manipulation suffers. The rough surfaces, although they are to be preferred to smooth ground surfaces, are not satisfactory. The ideal material is still ivory, and the only thing which approaches it is aluminum. Aluminum has another quality in which it approaches ivory, that is, lightness; it is superior to ivory in the ease with which it stands dry sterilization. Aluminum, however, at least that which our instrument makers use, is not always pure and is spoiled by certain antiseptic solutions; but this is of no importance, as dry heat sterilization is to be preferred to boiling, and simple sterilized saline solution to so-called antiseptic solutions during the operation.

There is little or nothing to say against the form of the handles supplied to us by the best makers. The handle thickens a little in its third part nearest the blade, a section of it showing a rectangle with bevelled edges. The surface of the cataract knife blade, as the iridectomy knife blade, is parallel to the broad side of this rectangle. This is quite correct. Though we hold these instruments in a different fashion, one must always have the tip of the thumb on one side of the broad surfaces and the tips of the first and middle fingers on the opposing broad surface of the handle, so as to prevent its rotating on its axis without the operator's wish. If, on the other hand, he desires to rotate the instrument slightly, he must be able to do so easily; this the bevelled edges permit. The corners must therefore not be sharp but rounded somewhat, so that the movements can be made slowly and precisely.

It sometimes happens that the blades of curettes and vectes are placed perpendicularly to the broad side of the handle, instead of being parallel to it. This is an unpardonable fault.

It is natural that instruments which are rotated around their axes while in use should have a handle a section of which is square, with rounded rather than bevelled edges."

Acting, then, upon the hint given by Landolt, one may divide ophthalmic instruments into the following categories: (a), instruments with straight, slender handles; (b), instruments with large or crooked handles; (c), instruments with double or special handles; (d), instruments and appliances without handles.

Classification test for color-blindness. Edridge-Green, in addition to his lantern and spectroscopic tests, proposes what he calls a classification test. This consists of colored beads, in which every variety of confusion color is well represented, and a box with four compartments into which the beads can be dropped. These compartments are labeled red, yellow, green, and blue. The person examined picks the beads from the white porcelain-lined holder; first the red, then each of the other colors successively, selecting those of one hue, although lighter or darker.

Claude glass. CLAUDE LORRAINE MIRROR. A convex, blackened glass that acts as a mirror.

Clausius, Rudolf (1822-88), German physicist, born at Köslin in Pomerania, studied at Berlin, where he lectured on natural philosophy. He was afterwards professor at Zurich (1855), at Würzburg (1867), and at Bonn (1869). He was elected a foreign member of the Royal Society (1868), and in 1879 was given its highest honor, the Copley medal. His special work was his contribution to the science of thermo-dynamics, the honor of establishing which on a scientific basis he divides with Helmholtz, Joule, Rankine, and Thomson. In optics and electricity he made valuable discoveries. His great work is his *Abhandlungen über die mechanische Wärmetheorie* (1864; trans. by Hirst, 1867), which in its second edition took a more systematic form as vol. i. *Die mechanische Wärmetheorie* (new ed. 1887), vol. ii. *Die mechanische Behandlung der Electrizitat* (1879), and vol. iii. *Die kinetische Theorie der Gase* (1889-91). Other books are *Ueber das Wesen der Wärme* (1857), and *Die Potential function und das Potential* (4th ed. 1885). *(Standard Encyclopedia.)*

Clavus. An obsolete term used to describe a certain degree of prolapse of the iris through an opening in the cornea, the prolapsed portion of the iris being pressed flat like the head of a nail, hence the name.

Clavus oculorum. (L.) Staphyloma.

Clay, White. See **Argilla.**

Clear-melting. The maintenance of glass in a molten condition for a sufficient length of time to permit impurities to settle.

Clearness of black and white letters. The relative distinctiveness or clearness of black and white letters is of importance to ophthalmologists on account of their being used as tests of the visual acuity. S. S. Balch (*Scientific American,* Oct. 26, 1912) says that there is a general tendency on the part of railroads to adopt signs with white letters on a black background, not realizing that the black letter on a white background is easier to read and can be seen at a greater distance. This follows in an interesting way from the structure of the retina of the eye. The impression of a letter at the limit of vision is received on the ends of a small bundle of nerves which convey to the brain a sort of mosaic impression. A nerve can only transmit to the brain information as to whether or not a ray of light is falling upon it and when a nerve is partly in the light and partly in darkness the sensation is the same as though all of it was in the light. It follows, therefore, that all nerves on the dividing edge between any black and white area transmit the sensation of light so that all white lines and white areas appear wider and all black lines and black areas appear narrower than they really are. Two black letters grow thinner at the limit of vision and are still recognizable, while at the same distance the two white letters grow thicker and cannot be distinguished. There are circumstances when it is necessary to use white letters, but in such cases legibility will be improved if they are made with a thin stroke and strongly lighted. Black letters are more distinct if made with a heavy stroke. See **Examination of the eye.**

Clearness of vision is dependent on the space between the retinal cones in the macula lutea. To be clearly seen an object must practically subtend an arc of 60 or 70 seconds in the field of vision. The image of such an object produces an image of about 1/12000 of an inch in the retina, and this is approximately the distance between the cones.—(J. M. B.)

Cleavage figures of the lens. On the inner face of the outer wall of the optic cup nuclear spindles or cleavage figures form, indicating the ectodermal rudiments from which both the lens and retina are finally developed.

Clef. (F.) Key.

Cleft eyelid. CLEFT LID. This is another name for *coloboma palpebræ* or fissure of the lid. See **Congenital anomalies of the eye.**

Clefts in Descemet's membrane. These clefts occur, though rarely, in buphthalmos, keratoconus, intraocular tumors and in progressive myopia. They are evidenced by curious curved lines lying at the posterior surface of the cornea. Two cases are, for example, reported by Stephenson (*The Ophthalmoscope,* June, 1906) one in a woman of 21 years with myopia of about 12 D., and the other in a child of 6 months with buphthalmos.

The Editor has reported (*Ophthalmic Record,* December, 1906) (see the figure) a similar case of clefts in Descemet's membrane due to, or associated with, a high degree of myopia. This lesion seems to result from mechanical stretching of the endothelium and inasmuch as the cornea reaches its full growth and powers of resistance early in life these linear ruptures are usually congenital or occur during infancy.

Cleidolabis. (L.) A small forceps with a catch.

Clement, George Colburn. A general surgeon of Haverhill, Mass., who paid considerable attention to ophthalmology and was widely known in the special field. He was born at Milford, Mass., Aug. 15, 1855, the son of James H. Clement and Clara Erskine Clement, the well-known authoress. His early education was received under private tutors. In 1871 he entered Dartmouth College, but, after only one year, proceeded to New York, where he began the study of medicine under Dr. A. B. Crosby. In 1878, his health having failed, he spent three years traveling in South America and California. He then matriculated at the Harvard Medical School, Boston, at which institution he graduated in 1880.

George Colburn Clement.

After his graduation he served two years, all told, in the Boston City Medical Hospital and the Boston Free Hospital for Women.

In 1882 he removed to Haverhill, Mass., where he practised until he died, doing both general and ophthalmic surgery.

In 1885 he married Matilda H. Kimball, daughter of George H. Kimball, of Haverhill. As the result of this union two children were born.

He was a member of numerous medical societies, general and special, and was very active in society work; yet he wrote but little.

He was surgeon and ophthalmologist to Hale Hospital at the time of his death, which occurred Aug. 27, 1909.—(T. H. S.)

Cleomedes. This brilliant astronomer, who flourished in the first century of the Christian era, is of especial interest to ophthalmologists because he is the first person in history to mention the refraction of light. Some of the mere facts, or phenomena, of refraction had, of course, been noted by many persons before him. Thus, Aristotle had observed that a staff, part of which is immersed in water, appears to be broken at the place where it enters the liquid. He asked for the reason, but could not render it. Aristophanes, likewise, spoke of the burning-glass, and Euclid described the familiar experiment of placing an object in an empty vessel, so held that the object is just invisible, and then of bringing the object into view by pouring water into the vessel. However, no explanation of these matters was proffered until the time of Cleomedes. The memorable sentence is as follows: "The visual rays, streaming out of the eyes, can be bent downward by damp and misty air and so strike upon the sun even when this has gone below the horizon." For a complete understanding of the sentence, it is necessary to remind oneself that, at the time of Cleomedes (and long after) it was supposed that the visual rays proceeded from the eye to the object, rather than in the opposite direction—that, in fact, the rays were emanations which, so to speak, the eye sent out to investigate the object. Aristotle had taught differently, but his teaching was unheeded.—(T. H. S.)

Cleonis collyrium. (L.) A collyrium described by Celsus. It was made of equal parts of terra samia, myrrh, and grains of frankincense, mixed with the white of an egg. When used it should be spread upon linen cloths and applied to the temples and forehead.

Cleonis gluten. Cleonis collyrium (q. v.).

Clerodendrum serratum. (L.) A plant of the verbena family. An ointment is made of it for external application in headaches and affections of the eyes.

Clignement. (F.) Blepharospasm; blinking; winking.

Clignotant. (F.) Blinking.

Clignotement. (F.) Rapid winking.

Climacteric. MENOPAUSE. MIDDLE AGE. According to Parsons (*Pathology of the Eye,* p. 1305), ocular complications occurring during the climacteric are conjunctivitis and conjunctival hemorrhage, episcleritis, iritis, cyclitis, glaucoma, intraocular hemorrhage, primary optic atrophy, optic neuritis. The menopause often aggravates ocular disturbances due to nervous diseases, e. g. hysteria.

Climate, Ocular relations of. The law of Zeune, namely, that climate has much to do with blindness, and that it is proportionately less in the temperate than in the frigid zone, has already been discussed on page 1198, Vol. II, of this *Encyclopedia.* Although this theory does not explain entirely the proportion of asthenopia and blindness on the score of climatic influences, yet there is doubtless much to be said in confirmation of its general terms. Oliver (*System of Diseases of the Eye,* Vol. 4, p. 409) regards climate as a potent etiologic factor in producing eye symptoms. He says, "A glance at the indolence of those who, living in tropical and subtropical situations, are content to exist for many months of the year almost as the tree beneath which they rest to escape the heat and glare of the noon-day sun, will explain this. Here there is an absence of work—either mental or manual. Here nature in her generosity bids but to stretch forth the hand to pluck the fruit that furnishes both bread and water. Appreciate the unnecessity for apparel except for decency's sake. Realize the uselessness of permanent habitation where, as for the birds and the beasts, houses are everywhere. Here is man untutored and unread. Here he is simply a part of animation, with his few wants and his fewer desires, passing a brief holiday-time, to perish just as do the plant, the bird, and the beast, that to him have been at once his friends, his enemies, and his existence. Here, in such a life, in which there is no tendency to close or applied work; where to live is enough; and in which there are but few hereditary tendencies to ocular change and no disturbing employments; here must be most frequently found the normal and the uninjured flattened eyeball of man. How different is life for the dwellers of the rigorous climates of the North and the South! Fighting for every morsel of food to eat and working for each drop of water to drink; necessarily covered with protective raiment of many forms during the entire year; constantly trafficking and bartering for materials that cannot be grown or made in their own countries; and compelled to be surrounded with permanent dwellings to shield themselves and their families from cruel beasts, more cruel men, and most cruel nature: is it any wonder, when it is realized that to acquire the amount of knowledge and technique that are necessary to understand the duties which are required to preserve their existence, that their lives must be one ceaseless toil, and that every organ must be gauged to its utmost working capacity. From early childhood, schools must be gone to; during youth, colleges for both theoretical and practical knowledge must be attended; and during manhood, the application of such information must be incessantly applied. Moreover, for those who aspire to be the most successful in any one of the many pursuits in which they are engaged, increased mental and monetary capital above that of their fellows must be amassed: less skilled, perfunctory, and routine labor must be bought; competitors must be overthrown; and every detail of business must be unceasingly inquired into, corrected, bettered, replanned, and rearranged. In other words, in such a struggle for existence, man is undergoing constant physical labor. To live in such an environment, he is compelled to endure all of the evil consequences of wear and tear of structural organs; and hence, here in such a life, it is that the eye—the most useful and the most delicate end-organ in the organism—is unremittingly and ofttimes injuriously brought into play. So, too, with many other factors; each plays its etiologic part."

In judging of the effects of climate upon the eyes it must be borne in mind that the eye-tissues, as well as the nasal passages, of some individuals are peculiarly susceptible to atmospheric and climatic changes. It seems hardly necessary to state that a person so afflicted should, wherever possible, take up his residence in a district best suited to his condition. At the first premonition of the approach of an attack he should be advised to change his place of residence.

The effects of climatic changes upon the eyes seem to be felt particularly in hospitals, among patients whose eye-tissues are in a low state of vitality, and hence are more susceptible to such influences. During one outbreak of catarrhal conjunctivitis that occurred at Wills Eye Hospital the writer observed 19 cases develop within eight hours. This outbreak occurred simultaneously on both sides of the house, 12 cases appearing among the male patients and 7 among the female, although there was no possible means of direct communication between the two departments. These attacks occur almost invariably at the beginning of the rainy seasons, particularly in the spring and fall.

It has been noted, during the writer's observations in the Wills Eye Hospital, that, when such an outbreak of catarrhal conjunctivitis occurs among the patients, almost every inmate sooner or later succumbs to an attack of the disease, varying in intensity from a slight catarrh to quite violent symptoms. Hence these outbreaks are regarded with a great deal of apprehension, for, aside from the discomforts produced by the disease, the progress of the healing process is naturally retarded, and as a result of repeated attacks a chronic inflammation ensues.

The disease generally subsides as suddenly as it appeared. The writer has also observed the marked tendency of keratitis, conjunctivitis, etc., to follow upon climatic changes, and he has noted their influence to affect particularly the healing process after corneal sections.—(J. M. B.)

Climatometer. A thermometer or thermoscope intended for meteorological use.

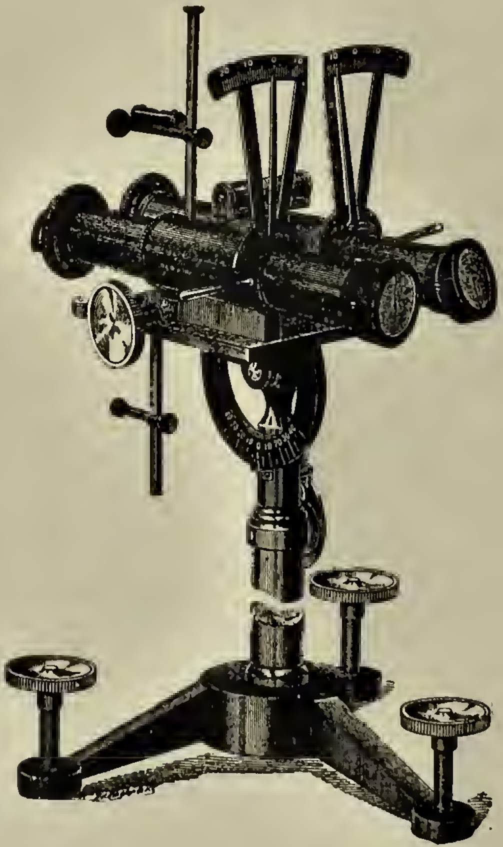
Clinical examination of the eye. See **Examination of the eye.**

Clinometer. An apparatus for estimating the rotational power of the ocular muscles.

Clinometer, Duane's. A device for estimating torsional deviations of the eye. This apparatus may also be used in the study of metamorphopsia.

Clinoscope. An apparatus for measuring the torsion or rotating power of the eye muscles when gazing at a fixed object. The visual axes are meantime supposed to be parallel, or nearly so.

Clinoscope, Stevens'. In the inventor's own words, several subjects of much importance in physiological optics have presented difficulties to investigators, and have been viewed from radically different standpoints by distinguished authorities, because of the absence of definite and sufficiently accurate methods of examining the phenomena on which the investigations have turned. Among these controverted questions is that of the actual direction of the apparent horizontal and vertical meridians of the retina.



Stevens' Clinoscope.

The doctrine of a declination of the vertical meridians, as indicated by the experiments of Volkmann, and as accepted by Helmholtz, has not been received by some other investigators with unquestioned assent.

"Researches of my own in this interesting field have led to the construction of an instrument of precision, which, I think, will prove of value in this inquiry and in inquiries allied to it.

The instrument, which I have called the clinoscope, consists of two cylindrical tubes, each about three centimetres in diameter and fifty centimetres in length. The tubes are mounted on a brass platform, which holds them firmly in the same horizontal plane, at a distance of 6.5 centimetres between the centers at a fixed point. The attachment to the platform permits the tubes to be adjusted in parallelism, in convergence, or in divergence in the plane of the platform. The platform is attached by a movable joint to the upright standard, so that the instrument may be given any desired dip; and a scale and pointer indicate, as in the case of the clinometer, the dip with respect to the horizon.

The tubes are caused to rotate upon their longitudinal axes by means of thumb screws, as seen in the figure, and the pointer and scale above the tubes mark the rotation with accuracy.

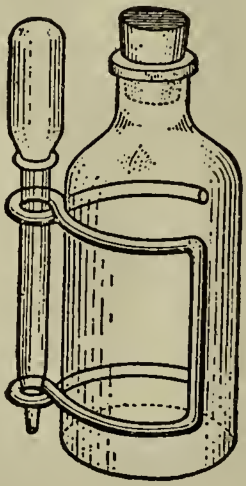
At the proximal end of each tube is a clip, in which, if desired, the observer may insert a glass for the correction of his refraction, or any glass from the trial case. At the distal end is another clip and provision for maintaining precise position of the diagrams to be used in the investigation. These diagrams are haploscopic figures, calculated to aid in the various experiments which may be made. These may be varied according to the wish of the investigator.

As the trained observer looks into the tubes, the two tubes and two pins placed within blend as one, and the head of the long pin now appears in the middle. An adjustment of the tubes by rotation on the long axis will show the true direction of the meridian, vertical or horizontal, according to the position of the diagrams, of each eye upon the scale above the tubes.

For testing the ability of the eyes to rotate upon the antero-posterior axis (torsion), a straight line running across each disc is the most useful figure. The lines may be placed vertically or horizontally. It will be found that the rotating ability is much greater when the lines are vertical.

The clinoscope is primarily an instrument for physiological research, but as a practical instrument, I have already found it of much value in determining the declination of the meridians in paralysis of the eye muscles, and in anomalous adjustments of the eyes in respect to the horizontal visual plane; and those who may be interested in determining the power of torsion or who hope to increase the torsional ability by exercise, will find the clinoscope a correct measure in the first case, and an efficient aid in the second."

Clip for a medicine dropper. The pipettes on the market vary so widely in caliber that they will not fit any single loop of standard size. When the pipette is too small the tip rests on the table, exposed to infection and displacement; when too large it cannot be inserted into the loop or removed without undue effort. Moreover, the single clip does not cling securely to the vial, besides being too difficult and expensive to manufacture.



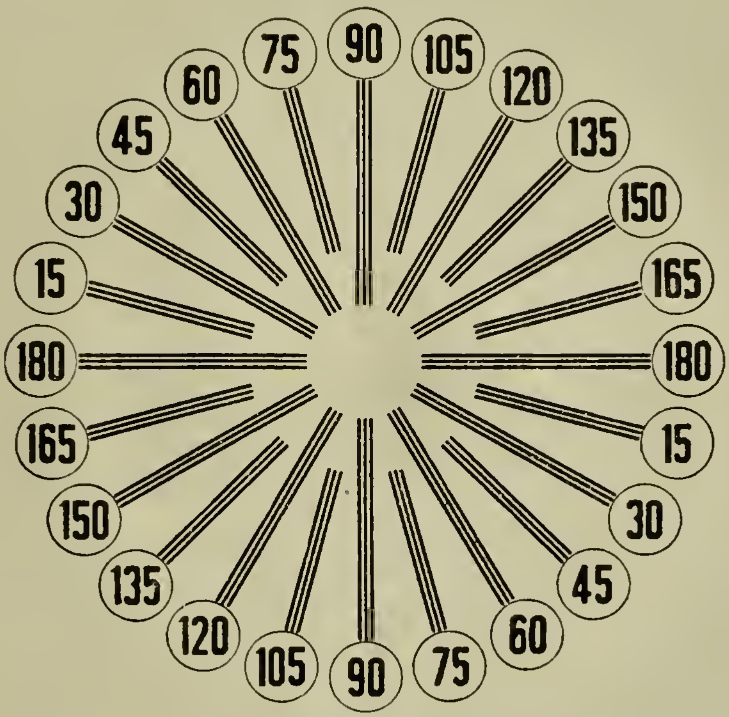
P. R. Wood's Medicine-dropper Clip.

Percy R. Wood (*Jour. Amer. Med. Assoc.*, Nov. 25, 1911) has contrived a clip which overcomes these objections. It can be made by any one, with the aid of a bit of wire and a pair of pincers, and will fit a bottle of any size. There are two loops, the top one sufficiently large to engage loosely a pipette of any size, while the lower one engages and supports the tip. The pipette can be easily removed and replaced.

Cliquetis métallique, Bruit de- (F.) Cracked-pot sound.

Clock-dial chart. See **Clock-face, Astigmatic.**

Clock-face, Astigmatic. The position of the principal meridians in ocular astigmatism may be determined subjectively by this device—of which there are many forms in the market. The principle of its use and method of employment is practically the same as that for other test figures. (See page 656, Vol. I, of this *Encyclopedia*.) As a rule, the most distinct lines correspond to the most ametropic meridian. For the correction of astigmatism the clock-face may, according to Jackson (*Diseases of the Eye*, p. 176) be used as follows: "If difference of clearness in the radiating lines is noticed, three parallel lines, small enough to be just distinguishable at the distance at which they are placed, may be turned in different directions, and that direction noted in which they appear clearest. By trial the spherical lens is then found which renders the lines most distinct in that direction. It is the measure of the ametropia in the meridian at right angles to the lines. The lines are then turned 90 degrees, and the lens found which renders them most clear in that direction. The difference between the two lenses measures the astigmatism."



Wallace's Astigmatic Chart.

The correction of the total ametropia may also be determined by putting in the trial frame such lenses as not only give the best vision but render clear, distinct and *uniform* the radiating lines of the clock-face. See **Charts, Test.**

Clockwise. In the direction of the rotation of the hands of a clock.

Cloison. (F.) Septum.

Clonic blepharospasm. In the clonic form of spasm of the orbicularis there is more or less blinking, which commonly affects both eyes and is generally hysterical in character, although it may be seen in non-hysterical cases when it is of the nature of *tic.*

Clonus nictatio. (L.) Clonus nictitatio. Rapid and repeated opening and shutting of the eyelids.

Cloquet, Angle of. This is a term used in facial craniometry and is formed by a line drawn through the ophryon, the alveolar point and the auricular-alveolar line.

Cloquet, Canal of. Hyaloid canal. Canal of Stilling. The vitreous humor is perforated posteriorly by a lymph space, which extends from the optic disc, where it forms a funnel-like area called the *area of Martegiana,* to the lens and marks the course of the hyaloid artery of pre-natal life. See **Canal of Cloquet.**

Cloquet, Jules-Germain. A famous general surgeon, discoverer of the Canal of Cloquet. Born at Paris Dec. 18, 1790, he studied the natural sciences at Rouen and medicine at Paris. Receiving at Paris his medical degree in 1817, he became in 1824 Extraordinary, in 1831 Ordinary, Professor of Clinical Surgery. In this position he devoted especial attention to diseases of the eye. Ten years later he retired from active work on account of ill health. Ten years later still (in 1851) he became Consulting Surgeon to the Emperor, and in 1855 Fellow of the Academy of Sciences. In spite of much and serious ill health he lived to be more than 92 years of age, dying Feb. 23, 1882.

In addition to important writings on urinary calculi and acupuncture, he composed the following works, all of which possess considerable ophthalmologic interest.

1. *Anatomie de l'Homme ou Description,* etc. (Paris, 1821-1831, 5 vols.)

2. *Mémoire sur la Membrane Pupillaire et sur la Formation du Petit Cercle Artériel de l'Iris.* (Paris, 1818.)

3. *An in Curanda Oculi Suffusione (Vulgo Cataracta) Lentis Crystallinæ, Extractio hujus Depressione Præstantior?* (Paris, 1824.)

The *"Anatomie"* above-mentioned contains (p. 361) the first description in history of the hyaloidian canal, now known almost universally as the Canal of Cloquet. The description (translated, of course) runs as follows: "At the level of the entrance of the optic nerve, the hyaloid membrane is reflected on itself, to form a cylindroid canal which traverses directly the vitreous from behind forward, and encloses the nutrient artery of the crystalline lens. This canal, which I believe myself to be the first to make known, and which I have named hyaloidian, can be perceived only when the membrane has been rendered slightly opaque, by means of procedures which I have described elsewhere.''

Though the canal itself had never been described before, yet, in 1812, Francisco Martegiani had described a slight dimple, or cone-shaped depression in the vitreous body, at the site of the optic papilla, which depression, therefore, in his honor, is called today the *area Martegiani*. Martegiani's book, containing this description, was first published in 1814.—(T. H. S.)

Close Braille. In alphabets and print for the blind (q. v.), this term indicates that form of Braille in which the space allotted to the first-base characters (including the following letter space) is less than that allotted to the second-base (including its letter-space). Most of the close Braille now being printed is Braille with New York intervals, but some has been printed with shorter intervals.

Clotted fibrinous cataract. An obsolete term for a false cataract formed by a clot or plug of fibrinous exudate that has occupied the field of the pupil and has become adherent to both iris and capsule.

Clou. (F.) Boil; large pimple.

Clou de Scarpa. (F.) Leaden cylinder or stylet used to dilate the nasal canal after incision of the lachrymal passages.

Clou hystérique. (F.) Circumscribed hysterical headache, generally at the vertex, giving the sensation as if ''a nail were driven through the skull.''

Clover's inhaler. This is one of the oldest—if not the oldest—special apparatus for giving a general anesthetic.

Cloves, Oil of. This is a volatile oil obtained from the unexpanded flower-buds of *Eugenia aromatica.* It has the usual qualities of the essential oils, and is a fragrant, yellowish-brown liquid. It has no particular value in ophthalmic therapeutics, but there are several instances of its irritant effects when introduced into the eye. Among these is the report by G. F. Libby (*Annals of Ophthal.,* July, 1912, p. 614), of a druggist who had broken a two dram vial of oil of cloves and received the contents in his eyes. The patient irrigated the eyes with water and then with alcohol, and instilled adrenalin. When examined an hour later, he had severe blepharospasm, lachrymation, conjunctival edema, and pain; the right cornea was partially denuded of epithelium, and the left wholly so; the right pupil was moderately dilated and the left ad maximum. Vision, O. D., 5/30; O. S., 5/22. The treatment consisted of homatropin and holocain, each in vaselin, bandage, and rest in bed. In two days the right corneal epithelium was restored, the left nearly so: and vision was O. D., 5/9, O. S., 5/15. In another four days all discomfort had ceased. Three weeks after the injury the vision and use of the eyes were normal, but a thin linear scar remained opposite the lower pupillary space of the left eye. As the patient had used no mydriatic prior to the first examination, the mydriasis was to be attributed to the effect of the burn.

Clysoir. (F.) An enema tube.

Clystère. (F.) Enema.

cm. Abbreviation of centimeter.

Cnethocampa processionea. The zoological name of one of the caterpillars whose hairs produce *ophthalmia nodosa.*

Cnidosis. This is a name given to the chronic form of urticaria, or hives, which sometimes attacks the eyelids. Its *treatment* is by pilocarpin, quinine and bromides, internally. It has been known to continue for years in spite of all treatment.

Coagulated cataract. A term applied by Mackenzie to a form of (spurious) fibrinous, cataract; a deposit on the anterior capsule due to some form of exudative disease of the cornea or uveal tract.

Coagulose. The trade name for a serum used in hemophilia (q. v.) as a preventive of excessive hemorrhage. It is said to be indicated in ''bleeders,'' upon whom it may be necessary to do any of the bloody operations of ophthalmic surgery, such as enucleation, cataract extraction, etc.

Coagulum aluminosum. (L.) Alum curd.

Coalescence of the eyelids. This is a term used in the embryology of the eye to describe the union of the margins of the eyelids during fetal life. They remain in this condition until shortly before birth.

Coal miner's neurosis. A name suggested by Jameson Evans for *miner's nystagmus.* T. Harrison Butler (*The Ophthalmoscope,* Dec., 1912), advocates adopting the term for the reason that the disease is solely confined to workers in the coal mine, and is a different clinical entity from occupational nystagmus. He also holds that nystagmus is not essential to the diagnosis of the disease, and describes three cases in which it was absent. He proves by case reports that hemeralopia is a symptom of the disease; but that refractive errors were no more common than among normal miners. Relapses are the rule, and the author believes the miner who has suffered an attack of miner's nystagmus will never be able to return to his work without a recurrence of its symptoms.

He believes it to be a central cerebral disease, like the nystagmus of insular sclerosis. It is characterized by twitching and rhythmic movements of the various groups of muscles, the ocular muscles being chiefly involved. The hemeralopia is still a puzzle and requires elucidation. Affected men always appear to be highly strung and of nervous types. The disorder of coordination is caused by a condition which is peculiar to the colliery. Lack of light is an almost certain factor. Inhalation of poisonous gases may be a cause, and there are probably other factors which have so far escaped notice.

Coarctation of the retina. Complete retinal detachment; resembling a funnel with its broad opening applied to the ciliary processes and its narrow end adherent to the optic disc.

Coats' disease. Exudative retinitis. This retinal affection may, according to deSchweinitz, "be present as a violent *neuroretinitis* from the beginning, or it may start as a degenerative type and assume inflammatory action. The latter begins without inflammatory changes, the white spots are small, often quite minute, and separated by comparatively normal areas, and the hemorrhages, if present, are inconspicuous, being confined largely to the nerve-fiber layer. The arteries are sclerotic, the veins dark, and the disc, in the early stages, blurred and indistinct, but there is no peripapillary zone of white exudation and no macular figure. If hemorrhages are the most conspicuous feature of the disease, the term *hemorrhagic* is applied; if the changes are almost wholly confined to the optic papilla, the *neuritic* or *papillitic* type is developed."

Gilbert (*Archiv f. Augenheilk.*, Vol. 75, pt. 1, 1913) in discussing the article of Coats (*Klin. Monatsbl. g. Augen.*, Graefe's *Arch.*, Vol. 81, 1912) thinks that juvenile vitreous hemorrhages, periphlebitis of retinal vessels, Coats' exudative retinitis, v. Hippel's and Leber's disease should be classed together as due to vascular disease, and that in all the cases in which an underlying cause can be made out tuberculosis or the tuberculous tendency will be found. In addition these diseases seem chiefly to affect persons suffering from the milder forms of tuberculosis. He states that in his opinion such vascular disease of the central vessels and those of the uveal tract play a much more important part in the eye diseases of young people than has hitherto been thought to be the case.

He agrees with other authors in not having found much benefit from treatment with tuberculin.

Coats of the eye. These are generally regarded as three in number, namely, the external, sclerotic or fibrous coat—the sclera; the middle or vascular coat—the uveal tract, iris and choroid; the internal, inner or nervous coat—the retina.

Coaxial. Coaxal. Having a common axis.

Cobalt-glass tests. The deep blue or purple color exhibited in glass made from the salts of cobalt has been utilized in several ophthalmic tests. The most useful is that employed for the detection of heterophoria, recommended by William Thomson and others. This simple test will be found to uncover even very low degrees of heterophoria. A cobalt glass (or the superposed red and the blue usually found in trial cases) is placed before one eye, and in front of this is held a card. After waiting twenty or thirty seconds the card is slowly withdrawn laterally from in front of the pupillary space; and when the edge of the card has passed the visual axis two lights—one of a cobalt color, the other of the color of the flame—will be observed, if heterophoria exist. If orthophoria is present, but one light, of the color resulting from the superposition of the two images, will be seen. That prism or combination of prisms with which but one light is observed is a measure of the degree of heterophoria.—(J. M. B.)

Another use of cobalt glass in ophthalmic examination is for detecting the presence, and determining the character and amount, of *ametropia.* Although this test is not as satisfactory as some other subjective methods, yet when used with due regard to its insufficiencies, it may be considered a useful mode of examination. See, for example, the account of that patented device called **Chromatic eye-test.**

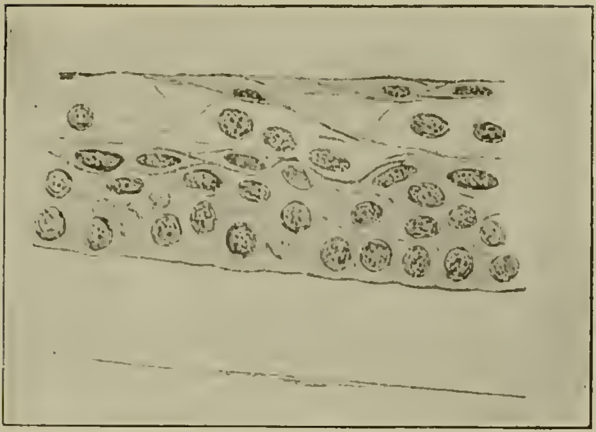
Cobitis anableps. A fish which, under the name of Callionymus, is said by Pliny (*Nat. Hist.,* xxxii, 24, 17) to be of use in lid-diseases, leucoma, and general weakness of the eyes.—(T. H. S.)

Cocaethyline. ETHYLBENZOYLECGONINE. $C_{18}H_{23}NO_4$. This is a white powder or occurs as colorless crystals. It is the ethylic combination with ecgonine just as cocaine is the methyl compound. This analogue of cocaine, whose taste is followed by numbness of the tongue and lips, results from the action of iodide on benzolecgonine. It is almost insoluble in water; soluble in ether and alcohol. As a local anesthetic its action resembles cocaine but is much milder than that drug.

Cocain-aluminium citrate. This double salt contains 3 molecules of aluminium citrate and 1 of cocain. It is found as crystals that are readily soluble in hot water but insoluble in alcohol. The agent is used as an astringent and as a local anesthetic.

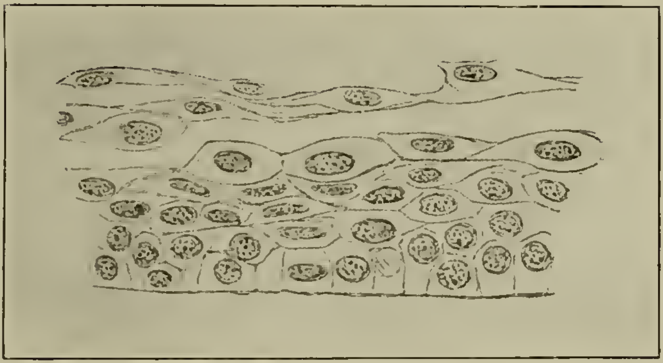
Cocain-aluminium sulphate. A compound of aluminium sulphate and cocain. It is used for the same purposes as cocain-aluminium citrate.

Cocain, Amblyopia from. Although cocaine is a systemic poison and a number of deaths have been recorded as a result of its ingestion, yet very few serious or dangerous symptoms have arisen from its use in the conjunctival sac. Many observers, however, have noticed temporary vertigo, weakness of the pulse, and even syncope from its ordinary application to the eye. No doubt this has occurred in persons exhibiting an idiosyncrasy against the drug. As a part of the general



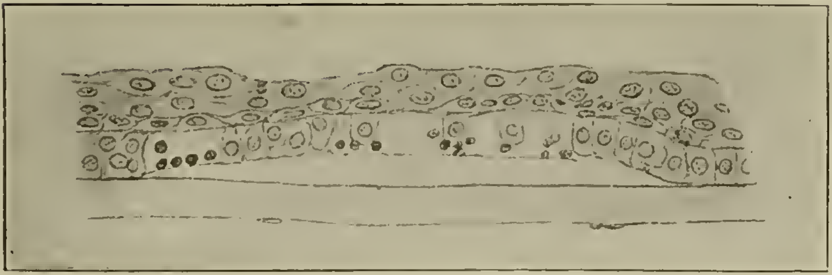
Action of Cocain on the Epithelium. (Parsons.)

Prolonged action of cocain before enucleation. Note the swelling and edema of one of the superficial layers.



Action of Cocain on the Epithelium. (Parsons.)

Exfoliation of superficial layers of epithelium.



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Desquamation of the superficial layers. Degeneration and coalescence of groups of basal cells, leaving free nuclei. This would eventuate in total desquamation and the formation of abrasions.

intoxication there have been noted maximum mydriasis and blindness due to the syncope. Contracted retinal arteries with a temporary loss of sight have also been observed after injecting the drug into the gums. Chronic poisoning from cocain has produced hemianopsia, chromatopsia, amblyopia, double vision, and even visual hallucinations.

Panas (*Archives d'Ophtal.*, Vol. 7, p. 97) claimed that cocain interferes with the regeneration of the aqueous, after paracentesis of the cornea. It is also quite well known that prolonged use of this drug, locally, reduces the normal tension of the eye, and its employment for an extended period prior to cataract extraction is for that reason objectionable.

The question as to whether the use of cocain is ever responsible for glaucoma has not been settled. From the fact that it generally reduces the tension rather than increases it is against that theory. However, Myles Standish (*Ophthalmic Record,* 1902, p. 243) mentions one case in which it seemed to have had that objectionable effect. The effect of cocain on the regenerative processes in the cornea has been investigated by a number of observers, among them Masugi (*Klin. Monatsbl. f. Augenheilk.*, 39, 1901), who agreed with earlier observers that the drug has a deleterious effect upon the corneal cells, and that it diminishes karyokinesis.

The effect upon the anterior epithelium of the cornea after a prolonged instillation of the solution, especially if the patient is allowed to keep his eyes wide open, is referred to under **Cocain.** As Fuchs (*Trans. Ophthal. Soc.,* Vol. 22) has shown the epithelium becomes first dull, then opaque, and is finally shed. Following this effect the basal cells (see figures) become changed into a mass with shrunken nuclei, and are here and there disposed in scattered heaps. Later, the whole epithelium may then become detached from Bowman's membrane and may be exfoliated. According to Parsons (*Pathology of the Eye,* p. 1002, Vol. 3) the effect of cocain is not entirely due to drying. This is proven by Bellarminoff's experiments in which the cornea was kept moist. By a colorimetric method he showed that after cocain the absorption of fluorescein was increased threefold. The investigations of Laqueur, Koster, and Silfvast show a specific deleterious effect upon the epithelium in man and the rabbit when great care is exercised to avoid drying. The endothelium also suffers, as shown by Mellinger; after injection of 2 per cent. cocain and ½ per cent. NaCl into the anterior chamber of a rabbit subcutaneous injection of fluorescein caused green coloration of the cornea, whilst the opposite cornea remained unstained. Cocain probably has also an indirect effect, probably through its constricting action upon the conjunctival vessels.

Bellarminoff has shown that cocain has no effect on the freshly dead eye; moreover, in the living animal its effect is diminished by previous section of the sympathetic, whereby the vessels remain dilated. This aspect of the subject is complicated, and requires further investigation. Thus tropococain is said to have a vaso-dilator action (Andogsky), whilst still increasing diffusion like cocain. Cocain, in consequence of its excitatory effect, causes contraction of the conjunctival vessels. According to Edmunds cocain produces exophthalmos from its stimulating effect upon the sympathetic. This condition being due to the contraction of the Müller's muscles, it thus simulates the main appearances of exophthalmic goiter.

Cocain benzoate. $C_{17}H_{21}NO_4$. $C_7H_6O_2$. This salt forms an almost colorless crystalline, gummy mass, soluble in water and alcohol. It is both anodyne and anesthetic, and is occasionally employed as a substitute for the alkaloid or the hydrochlorate.

Cocain cantharidate. $(C_{17}H_{21}NO_4)$ $C_{10}H_{12}O_4$. This white, odorless powder with a saline taste is soluble in hot, but insoluble in cold water. It has been used hypodermically in tuberculosis.

Cocain carbolate. A compound that appears as a crystalline mass, containing 75 per cent. of cocain. It is soluble in alcohol, insoluble in water and acts as an analgesic, anticatarrhal and local anesthetic.